THE NATIONAL GAS POLICY (2017): INADEQUATE GAS (PROCESSING) INFRASTRUCTURES AND THE MULTI-NATIONAL OIL COMPANIES' (MOCS) RESPONSES TO FLARE REDUCTION POLICIES IN NIGERIA.

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Abstract
This article attempts a review of the National Gas Policy on inadequate gas processing infrastructures inter-alia, and the responses of multi-national oil companies (MOCs) to gas flare reduction policies in Nigeria. The policy on natural gas (contained in the National Energy Policy, NEP, 2003) states that, "the nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry. Furthermore, the policy provides that, the nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network…" (NEP 2003:14). Yet, Nigeria lacks these critical infrastructures. The consequences of this are as follows: indigenous and foreign companies are reluctant to invest in the gas industry, and therefore, do not feel any sense of remorse when they regularly engage in gas flaring. Furthermore, adequate geographical coverage of the gas transmission and distribution is yet to be achieved. The article adopted an explorative approach; as such, data collection was entirely from secondary sources, including the internet, and analysed using content analysis. The article interrogates reasons behind the non-provision of these gas infrastructures. It examines the benefits derivable from putting the infrastructure in place as well as the shortfalls inherent in their absence and how this lack of gas infrastructure has promoted contained flaring activities. The study findings revealed that multi-national oil companies (MOCs)have taken advantage of the situation to continue the flaring of natural gas and decline to support the policies for gas flare reduction. The paper thus concluded that, the provision of gas processing infrastructure would go a long way in helping to check gas flaring activities in Nigeria.

Keywords: *Natural Gas, Gas-flaring, Gas Processing Infrastructure, MOCs, Government's Dual status.*

1. Introduction

1.1 Background to the Study

The policy on natural gas that is contained within the National Energy Policy, NEP, (2003) states *inter-alia*, that, "the nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry. Furthermore, the policy provides that, the nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network" (NEP 2003:14). Yet, Nigeria lacks these critical infrastructures. The consequences of this is as follows: indigenous and foreign companies are not encouraged to invest in the gas industry. Furthermore, adequate geographical coverage of the gas transmission and distribution is yet to be achieved.

The study identified three critical problems threatening the growth and development of the Nigerian natural gas sector in Nigeria. First which gave rise to the other two, is the lack of or inadequate provision of gas infrastructures. This has resulted in continuous venting and flaring of it as there are no means of processing them for the market. This gas flaring has far reaching economic, environmental and health implications. Though successive governments have been making effort both at reducing gas flaring and provision of infrastructures through policy and strategic approaches, Multi-national Oil Companies have not really been cooperating with the Nigerian government with its flare reduction policies for obvious reasons. One, government itself is an equal player in the oil and gas market, as such equally involved in the process 0of natural gas flaring and venting through its corporation, the Nigerian National Petroleum Corporation (NNPC) and its subsidiaries. Government which is churning out these anti-flaring policies is seen to be possessing dual status of a regulator on one side and operator on the other. It thus appears to these MOCs as if government is unserious. They had rather pay prescribed fines for flaring and get on with the practice.

1.2 Statement of Research Problem

The study identified three critical problems threatening the growth and development of the Nigerian natural gas sector. First which gave rise to the other two, is the lack of or inadequate provision of gas infrastructures. This has resulted in continuous venting and flaring of it as there are no means of processing them for the market. This gas flaring has far reaching economic, environmental and health implications. Though successive governments have been making effort both at reducing gas flaring and provision of infrastructures through policy and strategic approaches, Multi-national Oil Companies have not really been cooperating with the Nigerian government with its flare reduction policies for obvious reasons. One, government itself is an equal player in the oil and gas market, as such equally involved in the process 0of natural gas flaring and venting through its corporation, the Nigerian National Petroleum Corporation (NNPC) and its subsidiaries. Government which is churning out these anti-flaring policies is seen

to be possessing dual status of a regulator on one side and operator on the other. It thus appears to these MOCs as if government is unserious. They had rather pay prescribed fines for flaring and get on with the practice.

Meanwhile, these MOCs' interest is oil and not gas. Since gas is domiciled in the same reservoir with oil, with gas usually on top and oil under, it thus becomes necessary for them to burn it off so as to access oil, since facilities for their processing, transmission and distribution are either inadequate or not available. The MOCs now sees a justifiable reason to continue the flaring activity. To pay fines and continue flaring appeared to them a better economic option.

A third problem which this study examined and tend to want to proffer solution to and which also derived from the bigger problem of a lack of gas processing infrastructure is government's inherent weakness in implementing even the anti-flaring and flare reduction policies. Policy Implementation, which is described as the doing aspect of public administration, is the process of putting government programme into effect. It is the total process of translating a legal mandate into appropriate programme directives and structures that provide services or create goods. It involves a lot of details.

1.3 Study Objectives

The objectives of the study are to:

- investigate reasons behind the inadequacy of gas infrastructures in Nigeria.
- examine the benefits derivable from putting the infrastructure in place as well as the shortfalls inherent in their being inadequate or lacking, and
- assess how the inadequacy of gas infrastructure has encouraged flaring activities

1.4 Significance of the Study

This study is significant because, natural gas is a resource that is more abundant and widely spread. This implies that it is more diversified than oil in terms of availability. This diversified gas should ensure better security of supply (BP Statistics, 2017). Secondly, natural gas is making significant contribution to the world energy economy, because it is the cleanest of all fossil-based fuels, as natural gas emits 56.1 tCO2 per TJ while the emissions from oil and coal are 73.3 tCO2 and 94.6 tCO2 respectively (Subhes, 2011). According to World Energy Council (2013), Natural gas emits 30% less CO2 compared to oil and almost 70% less compared to coal for an equivalent amount of energy; Therefore, as the reduction of greenhouse is expected to gain momentum in the future, natural gas will surely strengthen its position and be a necessity for gas-based industrialisation and basis for sustainable economic development.

Indeed, the inadequate provision of gas infrastructures is major disadvantage to national development. Records have it that Nigeria was ranked high (9^{th} position) among global gas reserve holders. However, where most of it is flared due to lack of processing infrastructures, it results in fall in both GDP and *per capita* income. At the moment, a window of opportunity for increased gas utilisation is open to countries who can catch on

it. This opportunity is America's withdrawal of gas supply to Russia due to the on-going crisis it is having with Ukraine. So that the country could improve its gas processing facilities and increase its outside utilisation by resuming gas to Russia. This study is therefore both of immense relevance and timely too as it will serve the purpose of providing useful information on the activities within the gas value chain. relevant

Literature Review

Natural gas technically and in general, refers to gaseous form of petroleum consisting of mixtures of hydro-carbon gases and vapours, the more important of which are methane, propane, butane, pentane, and hexane (Davies, 1997). The term is also generally used for both Associated and non-Associated gas. Associated gas is that which occurs with oil in the same reservoir. Associated gas is either re-injected into the oil wells to enhance oil recovery where the situation of the reservoir permits it, or gathered and liquefied to provide alternative energy source for domestic use such as for electricity generation. On the other hand, Non-Associated gas occurs alone in a reservoir (Davies, 1997, Environmental Law and Policy of Petroleum Development, 2002). Gas Production, Transmission and Distribution combined in that order, are the three primary stages of the gas value chain. Natural gas production and marketing passes through these three stages. These three stages explain the interaction that goes on between producers and buyers in the gas market. The gas value chain entails the production, transmission, distribution, supply and the end-user of natural gas. Production or Generation is the process of extraction or exploitation of gas which is mostly in association with oil. Both production and processing take place at this stage and this occurs mainly at the oil wells in the Niger Delta region of Nigeria.

Transmission is concerned with the transport or movement of natural gas from point of generation or production through a high-pressured pipeline network to the point of use. The Nigerian Gas Company (NGC), the only wholesale supplier, owns and controls the transmission lines. It operates an un-integrated 1,100km of transmission pipeline capacity of more than 2bsf/d, 14 Compressor Stations, 13 Metering Stations and 8 Supply Stations (http://www.nnpcgroup.com/nnpc.group/ngc last visited on 21/11/2009). There are other transmission pipelines owned by the NLNG and the NNPC/SPDC/ Total Joint Venture specifically dedicated to their respective operations. Finally, Distribution is the process of transporting gas through low-pressured pipelines to the end - users. This is done in Nigeria by two companies, namely: Shell Nigeria Gas (SNG), and Gaslink Nigeria Limited (Gaslink). Gaslink has built about 100km of pipelines in Lagos for the supply of natural gas to industrial and residential users (Business Day, 2008). SNG also targets the supply of gas to power plants and industrial users.

The last two out of four policy planks of the National Energy Policy, NEP. (2003) states that, the nation shall put in place necessary infrastructure and incentives to encourage indigenous and foreign companies to invest in the industry, and secondly that,

the nation shall put in place necessary infrastructure and incentives to ensure adequate geographical coverage of the gas transmission and distribution network (National Energy Policy 2003). These emphasised inter-alia, that incentives and infrastructures would be made available both to encourage local and international investors to want to invest in the gas sector on one hand, and also to ensure adequate geographical coverage of the gas transmission and distribution network. The Natural Gas Master

Plan (2008) was actually designed to pursue these policy goals

Among the main aspects of the gas policy covered in the National Gas Policy (NGP, 2017) is that the policy shall identify and proceed with the development of key gas infrastructure and liberalise access to offshore and onshore gas transmission infrastructure and gas processing. The gas infrastructure blue-print was the heart of the Gas Masterplan (GMP 2008). The infrastructure blue print for the Gas Master Plan (GMP), which mapped out the planned gas pipeline infrastructure needed include: connecting the gas networks in the western and eastern parts of the country, building new pipelines from the south to Ajaokuta, and to Abuja and then to the northern part of the country. The first part of the infrastructure required the construction of Central Processing Facilities (CPFs) in the Niger Delta region to process wet gas supply to onshore gas transportation networks and industrial plants. Further to the Gas Master Plan, about 590km of gas pipelines have been completed and commissioned.

The gas infrastructure is divided into two major parts, namely:

- Gas Gathering / Processing and
- Gas Pipeline Transmission System.

2.1 Central Gas Gathering and Processing

This process entails the collection of wet gas from gas fields into a central facility for treatment and processing. Here wet gas will be dehydrated to acceptable standards and any element of undesirable compounds of carbons, sulphur and mercury removed before onward transmission into the grid. At these facilities, processes for the extraction of LPG and condensates will also be available; the recovered products will be supplied to the domestic market. This will solve the problem of liquid ingress into pipeline which has continually impacted power supply permanently. The Central Gas Gathering and processing facilities as designed in the blueprint is proposed to be located at the Warri/Forcados area, the Akwa Ibom/Calabar area and the Obiafu area (North of Port Harcourt). Only licensed investors within the franchise area will be allowed to develop and operate these facilities.

2.2 Gas Pipeline Transmission System

Grids of pipeline networks have been designed for construction and operation in the Blueprint. These networks of pipeline will transmit gas to areas of demand across the country. Three pipeline systems are incorporated in the blueprint:

- The Western Transmission System: This network comprises of the existing Escravos Lagos pipeline and a new offshore extension to Lagos. The new offshore extension will be connected to Lagos and ran through the western states to terminate at Jebba. The key market for this network will be the domestic market, feed industrial and residence demands and also the West Africa Gas Pipeline. Expected gas throughput is 3,250MMscf/d.
- The South-North Gas Transmission System: This, according to the World Gas Conference Technical Paper, will take dry gas from Akwa Ibom/Calabar Central Gas Gathering and processing facility to Ajaokuta, Abuja, Kano and Katsina. The line will also serve the Eastern states of Anambra, Abia, Ebonyi, Enugu and Imo. Key market for this system will be domestic and the North Africa regional market, as the Trans – Sahara Pipeline will take its feed from the northern node. Expected throughput at peak is 3800MMscf/d.
- The Inter-connector System: This network is expected to link the Eastern gas fields with the other transmission systems. The system is developed as a grid, ensuring redundancy and multiple accesses to gas markets from any gas source. This increases the resilience of the gas market to pipeline disruptions.

The foregoing provides the basis for the establishment of a robust and liquid Nigeria gas market and also reveals a lot of gas transmission investment opportunities for investors. With these, gas availability and the deliverability as well as commerciality were meant to be assured. It is anticipated that over the next 4-5 years, a great part of the infrastructure will be delivered.

Almost 590km of pipelines have been completed and commissioned further to the Gas Master Plan. These pipelines include:

Table 1: Completed Pipelines Commissioned Further to Natural Gas Master Plan.

1. Obene Geregu	190km
2. Expansion of Escravos-Warri-Oben	110km
3. Emuren-Ikoti	50km
4. Itoki-Olorunsogo	31km
5. Imo River-Alaoji	24km
6. Ukanafun-Calabar	128km
7. NOPL	50km

Source: *NGP, 2017:21*

With these projects now in place, all available power plants in the country today are connected to permanent gas supply pipelines. In addition, there is on-going construction of the strategies East-West OBS pipeline (127km) scheduled for completion by the end of 2017, and the expansion of the Escravos-Lagos Gas Pipeline system scheduled for completion by first quarter of 2017. The technical evaluation for the Trans Nigeria Gas Pipeline (140km) has also been completed.

Notwithstanding, the issue of a lack of critical gas infrastructure is still considered as one of the challenges facing Nigerian gas sector presently. The absence of enabling environment to attract foreign direct investments (FDI) in the gas sector which is but represented or brought about mainly with the lack of these critical gas processing infrastructure has affected the gas sector in Nigeria from appreciable growth and development. The slow progress with Nigerian gas export projects, slow pace of domestic gas projects, inadequate gas supply for the domestic market, financing challenges of FDI focus from Nigeria to other regions, and slow implementation of key infrastructure projects envisaged in the GMP are some of the issues involved and connected to the undeveloped gas infrastructure.

Meanwhile, NGP 2017 identified the key gas infrastructure needs and appropriate recommendations for upgrading the design of the existing natural gas infrastructure blueprint will be made to government. The required gas infrastructure will be identified under the following categories:

1. Existing Gas Infrastructure – This is to review existing gas transmission infrastructure in place
2. Gas Master Plan Infrastructure Blueprint – The following questions are addressed: What was planned in the GMP? What has been achieved? And What part are still valid now?
3. New Gas transportation links.
4. Upgrading National Gas Processing and Transportation companies (NGPTC) network – This will consider upgrades needed to the existing NGPTC network.
5. Alternative gas transportation such as CNG by road, rail or barge, LNG by road, rail or barge, and other vertical pipeline options that maybe identified are considered here
6. Key anchor customer infrastructure – This relates with the investment required at key anchor customer sites, e.g at Ajaokuta street
7. Distribution Infrastructure – refers to the local distribution companies licensed by the petroleum regulatory authority
8. Security of gas supply investment – This aspect addresses the additional infrastructure needed to improve the robustness of the Gas infrastructure Blueprint and ensure gas supply security
9. Resource clusters – this implies the identification of gas resources and clusters.

10. Identification of critical gas infrastructure. Critical gas infrastructure here refers to the following:
    a. Aba-Owerri-Nnewi-Onitsha Pipeline Project
    b. Calabar-Ajaokuta Pipeline (CAP) Project
    c. Ajaokuta-Kaduna-Jebba Pipeline Project
    d. ELP-Ibadan-Jebba Pipeline Project
    e. Obiaju-Obrikom-Oben (OB3) Pipeline Project
    f. Expansion of ELP (Phase 2) Project
    g. Oso platform to QIT Pipeline project
    h. Erha/Bosi Pipeline Project *(NGP 2017:65)*

The policy states, further that, entry into the midstream will be liberalised and incentive to allow private sector investors to develop infrastructure to process, transport and store natural gas. This is not different from a provision of NEP (2003). It is rather amazing that that this desire of government to develop the gas infrastructure to the level of encouraging MOCs and other local investors to invest into the sector is far from being realised.

This paper thus views this provision of the provision of gas infrastructure as a mean of encouraging investors into the gas sector if there are visible constraints along the line. In particular, the paper examines the effect of this to the responses of MOCs to the gas flare reduction policies.

A joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) document "strategic Gas Plan for Nigeria (2004)", states that, the paramount need in the midstream sub-sector is to encourage the development by the private sector of what will be a highly capital-intensive offshore infrastructure as it would need to address such questions as:

1. Degree of separation of the pipeline development from upstream and downstream elements.
2. Over-sizing of the infrastructure to later for future gas development and potentially open access for a certain percentage of capacity.
3. Capability to expand offshore processing and compression.
4. Pipelines capacities, including questions of pre-investment for line over sizing Pipeline access (including issues of non-discrimination fair pricing, common carriage, etc.).
5. Pre-investment to facilitate future tie-ins.
6. Configuration and expandability of the onshore facilities.
7. Co-ordination of onshore pipelines (where relevant).
8. Co-ordination within country of the necessary legal, regulatory and institutional changes.

Among the strategies for the realisation of the natural gas policy (2003) is to encourage the establishment of the necessary infrastructure for the effective gathering, transmission for the export of natural gas.

2.3 Lack of Adequate Gas Processing Infrastructure

The vision of the NGP 2017 is "to be an attractive gas-based industrial nation, giving primary attention to meeting local gas demand requirements, and developing a significant presence in international markets". This policy is not different from others – good in formulation, but usually giggled down at the implementation stage. Whereas the issue of gas infrastructure is adequately provided for in the policy, it is yet to be adequately provided practically.

A probable reason for the lack of adequate gas processing infrastructure is its capital-intensive nature. It is therefore economically wise for MOCs to pay the prescribed fines for gas flaring that provide infrastructure for gas reinjection and processing for the market. Meanwhile, Ndukwe, S. O (2006) cited in Mokuye, C. S (2016) provides that the existing NGC infrastructural facilities for gas transmission are: 14 compressor stations – This comprise of 12 stations leased out to SPDC; 4 stations, namely:

2.4 The National Gas Master Plan

The National Gas Master Plan, NGMP (2008), was government's initiative to bring about private sector involvement towards an effective working of the production, transportation and supply of natural gas both to end-users and for exports. To achieve the stated policy objectives and successfully implement the strategies, various instruments, including economic measures, information and education, legislative measures and institutional arrangements are put in place and incorporated within the policy itself. Consequently, the strategies are prioritised into short, medium- and long-term stages respectively. At the short-term, The Policy will embark on:

- review and improvement of existing incentives to producing companies to encourage them to gather and utilise associated gas in order to maximise income from associated gas and eliminate gas flaring by 2008,
- review of existing penalties for gas flaring and ensuring that they achieve the desired effect,
- establishment of appropriate arrangements to ensure the implementation of the incentives and penalties to discourage gas flaring,
- monitoring the implementation of measures to achieve the termination of gas flaring by 2008,
- establishment of appropriate guidelines, regulations and incentives for the participation of indigenous and foreign entrepreneurs in the establishment of the *infrastructure* for, and business in, gas gathering, transmission and distribution,
- provision of funding for the establishment of a nationwide *infrastructure* for gas gathering, transmission and distribution,
- review and sustenance of the implementation of incentives to industrial and domestic consumers to use gas or change over to gas,
- sustenance and expansion of the measures presently in place for the

establishment of *infrastructure* and markets for the export of natural gas, and

- formulation of suitable urban and regional planning regulations, which are needed for the effective distribution of natural gas to domestic and industrial consumers.

The natural gas policy is a well thought out formulated piece, having in it all the ingredients needed for it to succeed especially in eliminating gas flaring and revamping the economy through improved natural gas gathering and utilisation. The following are the medium-term measures of strategies for the realisation of the natural gas policy:

- termination of gas flaring,
- sustaining funding for the expansion of the *infrastructure* for gas gathering, transmission and distribution nationwide,
- intensification of promotional activities for the use of gas and change over to gas by industrial and domestic consumers,
- implementation of urban and regional planning regulations for effective distribution of natural gas, and
- embarking on deliberate exploration for gas in promising parts of the country and at the long-term is the measures to put in place an effective nationwide *infrastructure* for gas gathering, transmission and distribution and for the export of natural gas.

However, despite these provisions, arrangements and measures coupled with other body of laws and policies before and after the policy being reviewed, and the different efforts and incentives of government towards facilitating successful implementation of the natural gas policy, and in this case, the making available of the needed gas processing infrastructures, the practice of flaring which appear to be the highpoint of the natural gas policy being reviewed, has continued in the Niger Delta with its attendant environmental, social and economic effects both on the host communities and the government. For instance, the flare phase-out date had kept on being shifted. The imposed penalties for flaring have not deterred MOCs (Multi-national Oil Companies) from continuing the willful combustion of associated gas. Also, it is noticed that the usual inefficiency in the performance of the power sector to deliver uninterrupted electricity supply is blamed on inadequate supply of natural gas to the PHCN's thermal generation stations. These observations among others, has led curious minds to ask, what is wrong with the implementation processes of the robust and well formulated natural gas policy? This study therefore, is embarked upon to unravel the untold story behind this puzzle.

2.5 Gap in Literature: Expected Contribution to Knowledge

According to Henry Biose et al (2019), there is inefficient gas pipeline development framework in Nigeria, as the existing pipelines (transmission and distribution) have been solely managed by the federal government, through its agencies and parastatals, which includes : Nigerian Gas Processing and Transportation Company Limited (NGPTC), Nigeria Gas Marketing Company Limited (NGMC) and Department

of Petroleum Resources (DPR) and they are in control of approximately 1,500 to 2,000 km of gas pipelines all over Nigeria, with limited or negligible private sector participation and this has resulted to having inadequate domestic gas supply obligation, because the pipeline infrastructures are not enough to meet the local demand of natural gas (Department of Petroleum Resource Annual Report, 2017).

According to DPR (2017), the Nigerian national pipeline capacity for the year, 2018 is 2.9 bscf/d with 2.0 bscf/d for the western region axis and 0.9 bscf/d for eastern region axis and this is relatively small to support economic development in Nigeria, while, according to the National Gas Policy (2017), there are proposed gas pipeline network, but the economics and commercial framework for this proposed pipeline network are still vague and need to be modeled for economic development from conceptual stage to operations, considering the Nigerian socio-economic conditions and long term framework, that would generate revenue to the Nigerian government and create positive economic multiplier effect such as increase in direct and indirect employment. The existing spread of gas pipelines is categorised into northern region, western region and eastern region. Consequently, Biose (2019) advocated that government monopoly on the gas sector should give way for an entirely private sector ownership and control.

2.6 Theoretical Framework

This study is anchored on the Systems Theory to indicate that both the gas and electricity sectors are systems with sub-systems represented with their value chain arrangement in such a manner that each of them and even the gas and electricity sectors are dependent variables on each other. The Systems Theory of David Eastein (1965) could lend some useful explanation in this study. The systems theory sees political life as a system of behaviour with established set of interactions for the authoritative allocation of the values of society through an input-output matrix. David Eastein devised a model of 'political systems, a major post-war invasion which contributed to an understanding of politics by simplifying reality but in some cases departed from reality.

According to Chih-Hui Lai & Sapphire Huili Lin (2011), Systems theory aims to explicate dynamic relationships and interdependence between components of the system and the organization–environment relationships. A system is established based on the structure and patterns of the relationships emerging from interactions among components. As a result of these emergent patterns and relationships, each system is different from another. In other words, unlike biological systems, components of social organizations have their own wills and intended purposes. In general, systems theory focuses on three levels of observations: the environment, the social organisation as a system, and human participants within the organisation. This multi-level focus can be traced back to the original pursuit of initiating dialogue among disciplines through systems theory.

It is argued that this pursuit can be accomplished through different ways. One of them is to find general phenomena that are observable across many disciplines. For

instance, it is common to find in any social systems where aggregations of individuals interact with one another and with the environment and develop interdependent relationships. The biological notions of population change and individuals' interaction with the environment can apply to human organisations. Populations refer to the aggregates of individuals defined by common attributes and experiencing dynamic growth and declines of individual components. Each population exhibits dynamic patterns of its own and engages in dynamic interactions with other populations. These are essentially the tenet of the ecological and evolutionary perspectives, which will be explained in a later section. The other approach is to examine the empirical fields through a nine-level hierarchy, arranged according to the complexity of the constituent unit of behaviour. These nine levels include: frameworks, clockworks, thermostat, cell, plant, animal, human organism, social organisation, and transcendental system (Boulding, 1956). Systems at levels four (cells) or above are seen as more open and complex, operating on permeable boundaries and the mechanisms of self-maintenance (Schneider & Somers, 2006).

The advantage of this latter approach in the form of a hierarchy helps expose the theoretical and empirical gaps that have not been covered in different disciplines. For example, it was shown that in the 1970s, theoretical systems were not fully developed to understand open systems and social organisations. This hierarchy is also used to explicate the degree to which the characteristics of agency are realised in systems. Six levels of the continuum include determined systems, reactive systems, goal driven systems, problem-solving systems, self-aware systems, and multivocal systems (Poole, 2014). In determined systems (level one), there is a lack of consideration of agency because systems function in a predetermined fashion whereas in multivocal systems (level six), agents can dynamically construct multiple selves in different situations that involve problem-solving and monitoring processes. In other words, if a system possesses higher levels of agency, it is likely to be flexible and adaptable to change. According to systems theory, components of each system are structured in a hierarchical ordering, and components are interdependent with one another in the system to the extent that one component cannot function without the support of other components.

Components of a system can be tightly coupled, where the components are closely interdependent, or loosely coupled, where the smaller subsets of tightly connected components are loosely connected to one another. At the organisational level, the organisations and other organisations in the environment are also interdependent on one another. Underlying this interdependence are the permeable boundaries, both within and among organisations. Invariably, social organizations have to maintain permeable boundaries of a certain degree in order to receive materials or export products to survive. The process of receiving resources (input) and exporting products (output) is the exchange process. When the raw materials are received, components of a system will work together to transform the materials into products exported to the environment. During this throughput process, the system is engaged in two types of feedback

mechanisms: negative and positive. Negative feedback is to correct errors in order to maintain the current state of the system whereas positive feedback is to change the system through improvement or growth.

A system desires to maintain its steady state or homeostasis by balancing the energy imported. If the produced output is below the goal based on the feedback, a system will import more resources and adjust the throughput process in order to maintain its desired state.

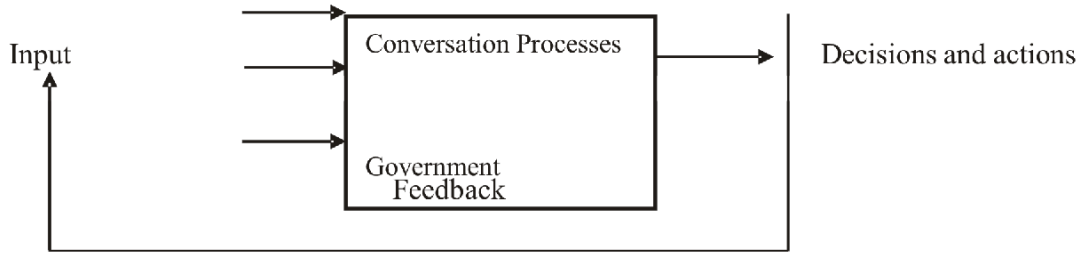

Fig. 1: A model of political system *(Adopted from David Eastein's A system Analysis of political life) - extracted from Roskin et al (2008:29).*

The idea of looking at complex entities are systems originated in Biology. Living entities are complex and highly integrated. The heart, lungs, blood, digestive tract and brain perform their functions in such a way as to keep the animal alive. Take away one organ and the animal dies. Damage one organ and the other components of the system alter their function to compensate and keep the animal alive. The crux of the systems thinking according to Roskin et al (2008) is that: you cannot change just one component, because a change in one component affects the other entire component. In the political system's model, many argued that the politics of a given country worked the same way MS a biological system. According to the Eastein Model as above, citizens demands, "inputs', are recognised by the government decision makers who process them into authoritative decisions and actions, 'output'. This output has an impact on the social, economic and political environment which the citizens may or may not like.

Methodology

The research, which is a qualitative one, adopted an explorative approach; as such, data collection was entirely from secondary sources and internet sources, and analysed using content analysis. This article interrogates reasons behind the non-provision of these gas infrastructures. It examines the benefits derivable from putting the infrastructure in place as well as the shortfalls inherent in their absence and how this lack of gas infrastructure has promoted continued flaring activities.

Discussion on Findings

The study findings revealed that multi-national oil companies (MOCs)have taken advantage of the situation to continue the flaring of natural gas and decline to support the policies for gas flare reduction. The three study objectives above are analysed here to reveal the submission of researchers on the subject matter.

Reasons Behind the Inadequate State of Gas Infrastructures

Henry Biose et al (2019) posits that there is inefficient gas pipeline development framework in Nigeria, based on the existing monopoly of the Nigerian Gas Processing and Transportation Company Limited (NGPTC) managing 1,500 to 2,000 km of gas pipeline all over Nigeria, while this is grossly inadequate to meet the domestic supply obligation. Extensive review of related literature was employed to obtain relevant data and information on the Nigerian gas pipeline. The study shows that gas pipeline is inadequate and additional 5,000km is required to meet the short and medium need, while about 10,000km gas pipeline will be needed in the long run.

Another reason is what Biose et al (2019) called, Gas Pipeline Economics in Nigeria; that is, the cost implication for the procurement of these infrastructures. Nwaozuzu (2018) states that typical natural gas pipeline construction costs vary between US$ 800,000 per km to US$ 2 million per km (for large diameter projects over rugged terrain) while a typical LNG project may require more than US$10 billion of investment and lead time of 6-10 years from conception to completion. LNG tanker ships cost about US$200 million. The cost associated with gas pipeline construction from global perspective is noted in this study, considering the fact that gas is a global commodity and the pipelines are designed to international standard such as American Petroleum Institute, National Association of Corrosion Engineer etc., while the typical cost associated with gas pipeline projects includes the following:

- 24-inch Yucatan Peninsula gas pipelines, completed in 1999 and running 432 miles from the Mexican State of Tabasco to power plants in the Yucatan province cost US$266 million.
- 460 km line completed in 1996, from La Mora in Argentina to Santiago in Chile cost US$360 million.
- The 3,700 km pipeline from Bolivia to Sao Paulo in Brazil cost US$1.8 billion.

Citing Biose *et al* (2019) further, there is no policy framework enacted by the federal government of Nigeria on gas pipeline transportation (gathering, transmission and distribution) that would support effective management of gas production and utilisation for economic development in Nigeria. The existing framework includes the following Acts, Plan and Policy documents:

- Petroleum Act (1969)
- Oil Pipeline Act (1965)
- Guidelines for the Construction, Operation and Maintenance of Oil and Gas Pipelines and their ancillary facilities

- Gas Master Plan (2008) – There is no formal document on the gas master plan.
- National Gas Policy (2017)

The aforementioned documents did not set out the framework for sustainable gas pipeline infrastructure in Nigeria. As a result of these problems, Nigeria has increasingly become a monoeconomy, that is highly dependent on crude oil exports with poor attention to gas development using pipeline transportation. The proposed strategy by Biose et al (2019) to enhance gas pipelines or infrastructural development in Nigeria is private sector-driven and divestment of all existing gas pipeline infrastructure to private investors in order to ensure sustainable management that would increase the Gross Domestic Product (GDP), create employment and provide access to relatively clean energy. Also, there is the need to have a gas pipeline transmission and distribution act that would stipulate the minimum requirement for gas pipeline investment in Nigeria.

The Benefits Derivable from Putting Infrastructures in Place, and the Shortfalls Inherent in their Being Inadequate or Lacking

Biose *et al* (2019) submits that, natural gas is a major contributor to the Gross Domestic Product (GDP) of many countries and it is employing thousands of people, generating millions of dollars in revenue and tax income. Natural gas is produced from the ground in large volume in order to be economically viable and from an international or global perspective; it is projected that $231 billion would be added to the United States of America economic performance in 2035 from the gas industry, while according to DPR (2017) Nigeria loses $10 billion due to gas flaring at the rate of $2.00 per MMBtu (www.igu.org/natural-gas-powers-economic-growth).

Furthermore, NMA (2016) states that typically, natural gas plays key role in manufacturing industries in many developed economies and the transmission pipeline is required to move the natural gas to the market; United States of America for instance, spent 25.8 billion in year 2015 for the construction of 6,028 miles (9701.13 Km) of natural gas transmission pipelines with creation of 347,788 jobs while according to DPR (2017) about $3.5 billion worth of inward investment was required to achieve the gas flare-out target by 2020 in Nigeria with projection of 300,000 associated jobs to be created. But as production and utilisation has been struggling to meet with domestic gas supply obligation due to lack of critical gas infrastructure, which is the pipeline and presently, there is a daily average domestic gas supply performance of 41% resulting from 1065.58 MMscfd supplied to the domestic market by eleven companies (DPR,2017).

The benefits above becomes derivable when the infrastructures for processing natural gas to the market is adequate and working effectively, otherwise, the reverse becomes the case. Conversely, Derefaka (2018) posits that Nigeria loses approximately $1 billion of revenue through gas flaring, due to its inability to capture and commercialise flared gas in the country. He further stated that, if flared gas was properly exploited, it had the potential to create 300,000 jobs, produce 600,000 MT of LPG per year and

generate 2.5 GW of power from new and existing IPPs, as approximately 700mmscf/d is flared at 178 flare sites in Nigeria. Diugwu et al (2013) examined the relationship of gas production, utilisation and flaring on economic growth of Nigeria using the classical Cob Douglas production, which posited that gas has a negative effect on the economic growth and that gas production is insignificant to economic growth in Nigeria ; However, Oduyoye et al (2013), explained that there was no causality between natural gas composition and Gross Domestic Product (GDP) in the short run and posits that Nigeria has not been able to tap her natural gas due to poor infrastructure and as a result most of the gas are being flared.

Conclusion

The article concluded that, the provision of gas processing infrastructure would go a long way in helping to check gas flaring activities as well as encourage local and foreign investors to want to invest in the natural gas sector of the economy. In as much as the MOCs are private sector organisations and characteristically would opt for what gives them comparative advantage, government, which want to pursue a programme of attaining a gas-based economy, may have to see to how it can on its own make adequate provision of the gas processing infrastructures., This will develop the gas sector and give it a competitive edge over other contenders in the global gas market particularly now that windows of opportunities are opening up in the industry. Furthermore, investments in power transmission infrastructure will enable evacuation of more power and increase gas utilisation for power generation. Digitise operations of gas assets to optimise infrastructure and ensure security of assets and improved return on investment for industry players.

Recommendations

In view of the immense potential of Nigeria's gas resources to stimulate industrialisation and economic growth, some recommendations to address the challenges across the gas value chain and spur the needed investment in the sector especially in the provision of adequate gas processing infrastructures include:

i. Commitment to the implementation of the national gas policy (2017) should be of priority to the government. Efforts should be doubled towards ensuring that the long-term action plans enshrined in the policy document are achieved.
ii. Incentives rather than fines for gas flaring should be emphasised as this will encourage the MOCs to want to invest in the gas sector.
iii. The relevant government agencies in the sector should go into negotiation with the MOCs for possible loint financing of the pipeline provision projects. Therefore, a Public-Private- Partnership (PPP) initiative is hereby recommended
iv. Boost institutional capacity and training for regulatory stakeholders.
v. The National Assembly should expedite action on providing legislative backing for the national gas policy document particularly the provision seeking to separate

the Nigerian Gas Company Limited (NGC) from the NNPC. This will ensure greater coherence and efficiency in co=ordinating industry players in the gas value chain.

vi. Government's efforts are recognised especially in transiting to a market-based pricing structure, as spelt out in the various policy documents and regulations such as the National Domestic Gas Supply and Pricing Regulations Proper gas pricing methodologies that consider the current and future dynamics of the gas market as enshrined in the national gas policy must be vigorously executed to optimise benefits from gas across the value chain.

vii. Put in place measures that would shield gas players in Nigeria from the adverse shock to the sector caused by the COVI19. One measure is to include short-term financial support and debt relief.

viii. Gas infrastructure should be rehabilitated through concessions Public Private Partnerships and improved to be more automated and equipped with the technology for better monitoring.

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