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Natural Gas Industry Restructuring for Value Optimisation: A Case Study of Ghana

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18 March 2020

Online at <https://mpa.ub.uni-muenchen.de/99155/>

MPRA Paper No. 99155, posted 18 Mar 2020 10:09 UTC

Abstract

The global natural gas industry in emerging oil and gas producing countries faces the challenge of restructuring and regulations, making industry conduct revaluation inevitable. The main concern in restructuring the natural gas industry in these economies is how to break previously vertically integrated companies into separate business entities under an appropriate market structure along the gas value chain. There are two schools of thoughts on how to restructure the natural gas industry. The traditional school of thought favours a vertically integrated structure and the liberal school of thought advocates for competitive-based structures encompassing different regulatory reforms including ownership unbundling. The natural gas industry in Ghana, though nascent, is growing due mainly to rising demand for electricity, at about 5.8% annually. Currently GNPC owns the upstream gas, midstream infrastructures and champions final gas delivery to downstream consumers. Gas price harmonization, easing contractual agreements, maintaining the survival of GNGC, and energy security reasons are among the policy factors that seem to favour a state-owned vertically integrated structure. The aim of this paper is to examine and determine the industry structure that is optimal to sustain Ghana energy supply mix. The paper offers two natural gas industry structure models to describe the effect of unbundling infrastructure ownership of natural gas along its value chain on energy supply mix in Ghana. The paper suggests maintaining the aggregating role of GNPC is appropriate. However, the paper recommends unbundling infrastructure ownership from upstream natural gas owners. Thus, the Gas Processing Plants and Ghana National Gas Corporation (GNPC) transmission pipelines need an independent entity to operate the GNGC transmission pipeline as the National Gas Transmission Utility (NGTU) with open access allow IPPs equal access to natural gas at the market hubs.

Key Words: *Vertical Integration, Unbundling, Natural Gas Industry, restructuring.*

1.0. Introduction

The global natural gas industry is facing the challenge of industry restructuring, regulation, and investment decisions and this has led to deregulation and altered the way the industry operates (von Hirschhausen, 2008). The main concern in restructuring the natural gas industry is how to break previously vertically integrated companies into separate business entities and introduce competition into the competitive segment of the industry. Whilst the traditionalist favored the vertically integrated structures, the liberals advocated for competitive-based structures encompassing different regulatory reforms including ownership-unbundling (Haase, 2009).

Unbundling of gas transmission networks is a highly debated issue and the concern is whether current transmission ownership argument is delivering non-discriminatory access and whether there are or indeed alternative arrangements that can deliver efficient and timely investment capacity (Pollitt, 2008). The European Commission named ownership unbundling of gas networks as the preferred form of organizing transmission networks (Haucap, 2007).

There have been directives in Europe for the liberalization of their natural gas markets based on open access to network infrastructure and the unbundling of monopolists from competitive activities. The natural gas Directives of 1998/30, 2003/55 specified the line of reform for member countries to follow and the emphasis is placed on the separation of infrastructure from upstream and downstream activities (Polo and Scarpa, 2013) and the creation of independent

transmission operators (Pollitt, 2008). The debate of unbundling the gas transmission network and the creation of an independent transmission operator has become an issue of concern not only in the global natural gas industry but also in the nascent natural gas industry in Ghana where there are contentions of the vertically integrated state structure and potential usage of an existing gas transmission network.

The main issues in Ghana are three folds: 1. the current natural gas industry structure is vertically integrated with Ghana National Petroleum Corporation (GNPC) the dominant player. 2. The transmission pipelines are to be operated by the Bulk Oil Storage and Transportation Company (BOST) having the license as the independent transmission operator thus the National Gas Transmission Utility (NGTU) and not the infrastructure owner. And 3. There is an institutional conflict between the NGTU (BOST) and the infrastructure owners (Ghana National Gas Company). This study aims to examine the effects of unbundling the vertically integrated role of GNPC in the nascent natural gas industry through empirical and theoretical reviews and structural consultation with industry players. Discussions will focus on the kind of structure the nascent natural gas industry should assume: vertically integrated or unbundle which consequentially will discuss other concerns regarding the operations of an independent transmission network operator and solve the institutional conflict between the NGTU and the infrastructure owners. The study will shift the argument from Pollitt's (2008) focus on unbundling the transmission network alone to unbundling the vertically integrated structure.

An analytical framework is developed using *stakeholder interviews* involving interviews with major natural gas industry players both governmental agencies and the private sector to collect their views, comments, experiences, suggestions, and opinions on the industry structure on the natural gas industry in Ghana. Nvivo Version 11 is used to develop the various nodes and themes to provide topics to lead the discussions. Eight governmental (Ministry of Petroleum/Energy, GNPC, Petroleum Commission, GNPC, Energy Commission, PURC, VRA, and BOST) and five private companies (ENI-Ghana, WAGP, and some three IPPs) engaged in the natural gas industry value chain in Ghana were interviewed using a structured interview guide. These eight governmental agencies are the main companies involved in the vertically integrated structure undertaking activities in upstream production, processing, transmission and consumption of natural gas.

The rest of the paper is organized as follows: the next section two is the background of the natural gas industry in Ghana. Section three follows with review of literature that is divided into theoretical and empirical sections. Section four is where results are discussed and the final sections are the conclusion.

2.0. Background of the Natural Gas Industry in Ghana

There has been a surge in natural gas demand in Ghana in recent times as fuel for electricity generation in thermal plants and this is due to the 5.8% annual growth in electricity consumption (Ghana Grid Company, 2010). Existing electricity generation capacities are unable to meet the staggering growing demand resulting in shortfalls in power supply and power outages. The hydro-dams are the base-load plants, producing at maximum capacity, which is supplemented by thermal plants as peaking plants that use Light Crude Oil (LCO) as fuel but are risk dominated due to volatile global crude oil prices. Alternative fuel to the thermal plants is natural gas and the existing West African Gas Pipeline (WAGP) transmitting natural

gas from Nigeria to thermal plants is currently inadequate and unreliable. An immediate solution are attempts made by the Ghana government and the private sector to monetized domestically discovered associated natural gas which was previously flared as an alternative fuel to these thermal plants.

A taskforce was inaugurated in 2011 to help monetized domestically produced natural gas to prevent flaring (Ghana National Gas Company, 2015). A midstream natural gas company was formed to build midstream infrastructure responsible for receiving upstream associated natural gas processed into lean gas (methane) for thermal plants and Liquefied Petroleum Gas (LPG) for household and automobile fuel consumption (Suleman et al, 2017). A 150mmbtu/day Gas Processing Plant (GPP) and 114kilometres (km) lean gas transmission pipeline are built in addition to the West African Gas Pipeline to process and transport both domestically produced and Nigerian natural gas to thermal plants consumers in Ghana.

The natural gas reserves in Ghana stands at 6.4Trillion Cubic Feet (TCF) (Ministry of Petroleum, 2012) with 2.2TCF of associated gas and 4.2TCF of non-associated natural gas. There are currently the Jubilee fields, Greater Jubilee Fields, Tweneboa, Ennyrome and Ntomme (TEN) and the Sankofa Gas Project which are considered upstream discovered and producing natural gas fields in Ghana. Initially, the associated natural gas from the Jubilee fields was flared for crude oil production but since the building of the midstream infrastructures these gas are domestically consumed.

Ghana's natural gas reserves do not merit a global scale Liquefied Natural Gas (LNG) project because of the marginal quantities and the fact that there is an existing local demand for thermal power plants. However, in an attempt to develop the natural gas industry into a viable business worthy of investments is marred with several challenges including lack of adequate infrastructure in upstream facilities, transmission pipelines, LNG regasification facilities, compressors, pressure stations, downstream thermal plants to fully utilized the gas, and alternative industries also consuming natural gas. There is also the challenge of identifying an appropriate industry structure that is best-fit for the nascent natural gas industry.

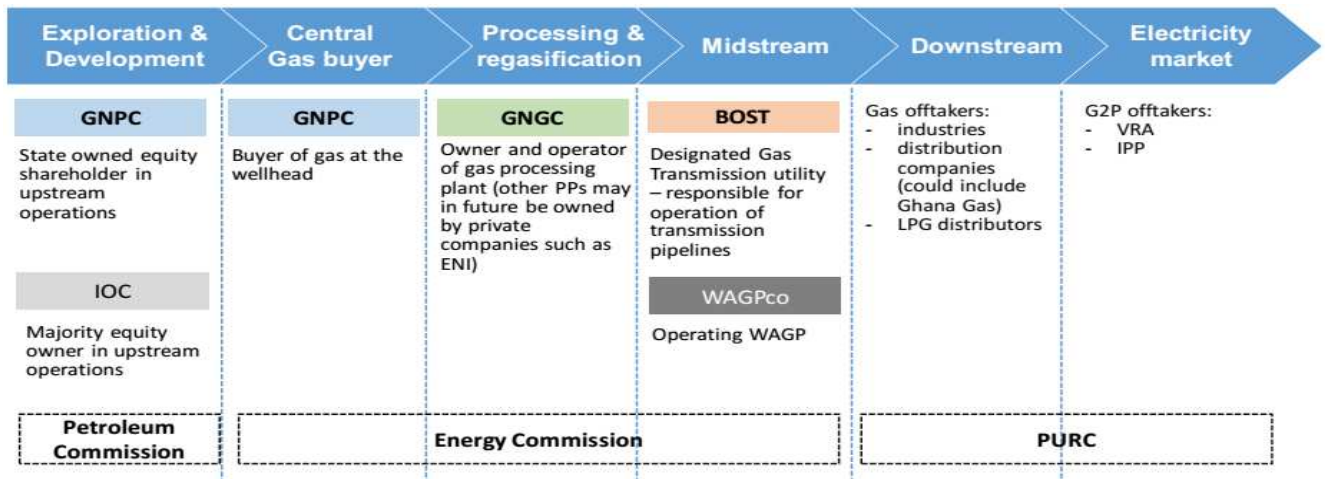
2.1. Existing Institutional Arrangements in the Natural Gas Industry in Ghana

Several players are operating in the natural gas industry. The Ministry of Petroleum is responsible for setting policies and monitoring of the petroleum sector and oversees all petroleum activities. Ghana National Petroleum Corporation (GNPC), set up in 1983 under Acts 64 and 84, is the national oil and gas company responsible for upstream exploration, production and development of oil and gas activities in partnership with international oil companies for upstream operations. The 2016 Petroleum Exploration and Production Bill captures how petroleum resources should be managed. The Petroleum Commission (PC) set up in 2011 under Act 821 is responsible for upstream regulation of oil and gas production, qualifying licenses, approving appraisal plans and implementing local content regulations.

The Ghana National Gas Company Limited (GNGC) is incorporated to build and operate a Gas Processing Plant (GPP) and the 114km transmission pipeline but has been acquired by GNPC (Ministry of Petroleum, 2015; World Bank, 2015). The GNGC is to operate as a midstream natural gas company providing infrastructure services. The Energy Commission (EC) is the downstream technical regulator of the natural gas industry and provides policy guidelines to the ministry of petroleum and gives advice to the ministry on regulatory issues. The Bulk Oil

Storage and Transportation Company (BOST) even though initially engaged in the transportation and storage of oil, was granted the National Gas Transmission Utility (NGTU) License by Energy Commission to be the operator and owner of natural gas transmission pipelines including the GNGC 114km pipeline and to operate the pipelines on third party access, and non-discriminatory basis.

Figure 1: Natural Gas Industry Structure and Institutions in Ghana



Source: ECA and PDC, (2014).

The West African Gas Pipeline Company (WAGPco) has been in the business of operating the West African Gas Pipeline, transmitting natural gas from the abundant supplies of Nigeria’s petroleum reserves to Ghanaian downstream thermal power plant consumers over the past decade for electricity production. The Volta River Authority dominate downstream electricity generation, producing about 70% of electricity whilst the Independent Power Producers (IPPs) are responsible for the 30%.

The Public Utilities and Regulatory Commission (PURC) is the economic regulator of the natural gas industry and responsible for setting tariffs for water, electricity and natural gas using the Automatic Tariff Adjustment Formulae and now for the natural gas transmission pipeline tariffs. Kosmos Energy discovered the Jubilee Fields in 2007 and consisting of other partners, Tullow Plc, Anardako, Petro SA and GNPC are producing from the Jubilee Fields with Tullow elected as the operator, including the discovery and production from the TEN Project. ENI and Vitol are also developing the Sankofa Gas Project and producing mostly associated and non-associated natural gas for the domestic market.

3.0. Literature Review

The literature review is divided into two sections: theoretical and empirical sections

3.1. Theoretical Review

Theoretically, this study will be exploring the related meaning and understanding of vertical integration and unbundling in network industries and the natural gas industry. Emphasis will be placed on the Transaction Cost Analysis theory and its application in vertical integration in a developing country and a nascent natural gas industry such as Ghana.

Should there be a single dominant player in the whole natural gas value chain? Vertical integration is the organization of successive production processes within a single firm (producing goods and services) (Riordan, 2005). Vertical integration is treated as an efficient response to contractual frictions (Williamson, 1979). Integration is seen as a tool for scale and scope economies, strategic motives and the fact that integration can be a tool for consolidating market power (Bolle and Breitmoser, 2006). Bolle and Breitmoser (2006) noted that gas networks are prototypes of natural monopolies and splitting them up is connected to higher cost. Research and industrial organization are taking a contrary approach emphasizing patterns of integration at a different market and industry levels. Whilst integration is seen from the perspective of broader models of industry structure, competition, and technological change, less attention is given to contractual issues and the way vertical integration might differ from sophisticated contractual arrangements of separated companies (Bresnahan and Levin, 2012).

Firms exist to reduce the cost of transactions through markets as Coase (1937) noted that a decision for a firm to vertically integrate rather than outsourcing its inputs or selling outputs should reflect the respective transaction cost of internal and market organization. Is vertical integration seen as a solution in reducing market transaction costs? Transaction cost of integration as Williamson (1971, 1975, 1985) and Riordan (2005) noted can be a great response to reducing market transactions when the view is held that market contracts are inherently incomplete and parties can plan for some contingencies and not all contingencies and there is room for opportunistic and inefficient behavior as transactions proceed and the consequences may be severe especially when complexities and uncertainties make it difficult to specify contractual safeguards or when parties cannot walk away without incurring substantial cost.

Transaction theory argues that integration can be an effective response when these features of asset specificity, uncertainty, complexity, and contractual incompleteness are present (Bresnahan and Levin, 2012). For example, as Williamson (1971) relates, in decision-making, when a dispute arises within an organization, it can be settled by a senior manager. In contrast, a dispute between separate entities is resolved by negotiations or litigations, as such integration can be an efficient response to uncertainty and contractual incompleteness. Further integration might be a potential for holdups, as if parties anticipate the possibilities of future haggling or disputes, they may have little incentives to make specific investments for fear the investments could be wasted or expropriated. Generally according to Bresnahan and Levin (2012), the variables of transaction cost analysis such as asset specificity, uncertainty, and complexity favor vertically integrated structures.

Vertical integration allows information flow that cannot occur across firm boundaries as employees who interact regularly within a firm develop a body of shared knowledge that facilitates further communication and once information is shared it cannot be rescinded. Vertical integration eliminates the “double marginalization” effect and results in lower prices of the final good (Riordan, 2005) and vertical integration is assumed to raise profits and benefits consumers.

How can the transaction cost theory as postulated by Coase (1937) and extended by Williamson (1971, 1975 and 1985) be applied to a nascent natural gas case in a developing country such as Ghana? Vertical integration is most applicable to the initial stages of the natural gas industry development to reduce hold-ups and opportunistic behaviours, reduce conflicts, fewer complexities, less contractual difficulties, and fewer uncertainties in executing the

developmental phase of the industry. This is why the government led vertical structure by GNPC allowed an easy and timely monetization of the domestic natural gas industry.

When does it matter to vertically integrate? For productivity, efficiency and cost benefits (Bresnahan and Levin, 2012). The source of this productivity is better logistics coordination as Hortacsu and Syverson (2012) used establishment-level data from a broad range of industries to show that integration, plant size, capital intensity, and labour productivity are positively correlated. Integration offers more control than a market contract and a greater ability to coordinate decision-making. Price discrimination can be promoted through integration.

Contrarily, vertical integration alters industry conduct to the detriment of consumers and competitors through anti-competitive foreclosure, facilitates collusion (Riordan, 2005). Asset specificity will make it difficult for new entrants and will promote monopolistic behaviours from the incumbents. Vertical integration of network and supply of gas leads to a conflict of interest, resulting, inter alia, in distorted investment incentives (Pollitt, 2007).

Historically networks are vertically integrated and owned by the producers. Regulation is to ensure that the network users are offered access at “competitive” prices and without discrimination (Bolle and Breitmoser, 2006). To ensure common access to the network is to unbundle the vertically integrated structure. Ownership unbundling of transmission may occur at the time of restructuring and unbundling is likely to be cheaper when other reforms are taking place (Pollitt, 2008).

3.2. Empirical Reviews

Unbundling has three or four degrees (Bolle and Breitmoser, 2006):

1. Accounting/functional/administrative unbundling, the firm remains integrated but re-organizes its book-keeping so that costs of the network services can be identified. And then there is management unbundling, as Kunneke and Fens, (2007) noted, in addition to the account separation, staff are assigned to different business divisions/units that function independently from other business activities but are still managed from the main company
2. Legal unbundling: the network services are provided by a separate firm that may, however, be connected with the production and trade activities of the previously integrated firm via a holding structure.
3. Ownership unbundling; the company who owns and operate the transmission assets is fully separated from the rest of the system (Growitsch and Stronzik, 2009) in addition to legal unbundling, the holding company has to sell either its network or both its production and trade arm (Bolle and Breitmoser, 2006), meaning that it has no further claims in retail or production and import (Growitsch and Stronzik, 2009).

Accounting/functional unbundling is not regarded as vertical separation since this does not quell well into the intended separation in legal and ownership unbundling (Steiner, 2000). Bolle and Breitmoser (2006), compared consumer prices between legal unbundling and ownership unbundling and concluded that legal unbundling has more preferable consumer prices, maintains a certain degree of vertical integration but strengthens the competitive forces required for efficient production. Growitsch and Stronzik (2009), analyzed the effects of

ownership unbundling of gas transmission networks on the level of end-user prices and concluded that there is no significant effect of ownership unbundling on prices. The unbundling of generation and transmission and the expansion of Third Party Access reduce both industrial end-user and the ratio of industrial prices (Steiner, 2000).

Unbundling in the natural gas infrastructure network is the set of multiple network infrastructure use to transport gas in a trade zone work as a single gas network. Traders will have to enter this network to trade gas in trade zone (Newberry, 2002). Network infrastructure is considered an essential infrastructure that is operated by the Transmission System Operators as franchised monopolies and regulated by an explicit and detailed network code (Vazquez, Hallack and Glachant, 2014). Gas transmission networks are not necessarily a natural monopoly especially when each pipeline is considered as an independent facility and serves as an alternative transmission in an industry. Full ownership unbundling changes the behavior of the network infrastructure as experienced in the UK market (Bolle and Breitmoser, 2006).

3.3. Arguments for and against Ownership Unbundling

The main advantages of ownership unbundling are fewer incentives/opportunities for discrimination; fewer incentives/opportunities for cross-subsidizing; and a more effective and efficient regulator (Tonjes, 2005). Pollitt (2008) noted that ownership unbundling will improve competition, ease of regulation, facilitation of privatization, synergy, make foreign take-overs more likely and reduce the risk of arbitrary government interventions. And ownership unbundling proves to be a disincentive against corruption in the face of lobbying utilities (van Koten and Ostmann, 2008).

Haucap (2007) noted that there are two main benefits of ownership unbundling: the decrease in the network operators incentive to discriminate between affiliated and independent generators and/or retail companies; and the increase in the network operators incentive to invest in cross-border transmission capacities (interconnection capacity) as vertically integrated companies have reinvested significantly less of the receipts from cross-border congestion rents than fully unbundled ones, 17% compared to 33%. Ernest and Young (2006) through a regression analysis stated that there is a significant relationship between industrial gas prices and the existence of a separate transmission system operator (ownership unbundling) and gas prices seem to be around 15% lower as a result of unbundling.

Contrarily to the arguments for ownership unbundling, Growitsch and Stronzik (2009) held the view that unbundling should only be introduced into the gas industry as a regulatory system if it improves social welfare and that unbundling do not lead to lower downstream gas prices. There would be upfront cost in reorganization and physical separation of businesses and contract renegotiation cost (Pollitt, 2008) and double marginalization between the formerly incumbent separated integrated business which is an inefficient price transfer (Bolle and Breitmoser, 2006). Unbundling raises transaction costs as this takes away the effects of economies of scope and scale. In smaller countries (ie Ghana) where the scale of competition may be limited and managerial expertise is scarce, the benefits of unbundling are likely to be small to the cost where there is the need for an independent regulator and another company (Pollitt, 2008).

Haucap, (2007), identified that there are two main types of cost potentially arising from ownership unbundling: firstly, as vertical separation will lead to the double mark-up problem

since transmission charges are not usually based on incremental cost, but include a mark-up to cover fixed and common costs, a second mark-up will be added at the retail and /or generation stages if these markets are not perfectly competitive. In the end, vertical separation may well lead to higher prices than vertical integration. And secondly, incentives to invest in network reliability are likely to decrease. The main reason is that an integrated operator has “double” the incentive to ensure that the network is reliable. The specificity of network investment further reduces investment incentives if companies are vertically separated and investment specificity has been the main reason for vertical integration. And the double mark-up reduces the investment incentives of separated network operations as it reduces its profits from additional investments. Two cases of unbundling in the EU and USA are further discussed below.

3.4. Unbundling in the EU Gas Transmission Network

The European Commission names ownership unbundling of gas transmission networks as the preferred form of organization of transmission ownership with an option of an independent system operator (ISO), (Pollitt, 2007).

With the first Gas Directive of 1998(98/30/ES), the EU sought to open up the midstream market. It provided for regulated or negotiated third-party access (TPA) to the national transmission and regional distribution network, via a step-by-step introduction of free choice of suppliers to large-, medium and small-scale customers. A second Gas Directive in June 2003 (2003/55/EC) was adopted. Regulated TPA became mandatory - meaning that approved and published tariffs would apply to transmission, distribution and LNG operators as well as balancing services. Transmission and distribution system operators had to be unbundled legally and managerially. A newly genuine element was the creation of national regulatory authorities (NPAs) for the energy sector and their main roles included approving and controlling tariffs (or methodologies), ensuring non-discriminatory network access and supervising effective unbundling (Correlje et al, 2014).

In the EU, the liberalization of the gas industry started with the opening of access to all transmission infrastructure. Open access is a conscious public policy to avoid exclusion of anyone into the use of a common resource and the infrastructure owner has no right to discriminate among potential users and should allow large numbers to access the infrastructure. Open access is implemented by the choice of making it difficult to exclude players from accessing the transmission network. For the potential user, open access is the right to access the transmission facility, the right to be connected and become a user.

Incumbents remained dominant in the EU gas market and largely controlling gas imports and/or indigenous production. Incumbents rarely entered other national gas markets as competitors and the free capacity available on cross-border import pipelines was limited. New entrants had to procure gas on weakly developed wholesale markets while despite third party access and unbundling often lacked effective access to the networks and this crucially affected competitive conditions at the retail level.

To address these issues a third Gas Directive (2009/73/EC) was approved in July 2009 to introduce common rules for the transmission, distribution, supply, and storage of natural gas. Member states were required to unbundle natural gas transmission systems and their operators from trading parties and allow market participants access to gas hubs (Correlje et al, 2014).

Contrarily, most of the companies in the upstream and midstream industry, often in public ownership, were against liberalization, as introducing competition would mean they would lose market share and their profitability would be affected. And liberalization was thought to introduce the creation of sector-specific regulations and/or regulators and most member states feared that they would lose their grip on their energy policy (Correlje et al, 2014).

In a third package, an Agency for the Cooperation of National Energy Regulations (ACER) was created to play the role of a central aligning national market and network operator rules as well as facilitating investments in trans-European infrastructure (Correlje et al, 2014).

3.5. Unbundling in the US Gas Transmission Network

In the USA, Federal Energy Regulatory Commission introduced order number 636, which made mandatory for pipeline companies to unbundle their gas trading from their pipeline operation activities – a requirement that led every major pipeline company to get out of the sales business and establish a separate transportation and trading affiliates. The order 636 and 637 further brought about transparency, flexibility in trading practices, facilitated short-term capacity resale, shippers choice in delivery location and the standardization of contracts and pipeline system operations. Natural gas regulation has matured and unbundled, non-discriminatory transportation is the norm in the industry. The decisions to restructure the natural gas industry in the USA reflected regulatory attempts to solve a variety of conflicts of interest between industry and consumers. Regulatory adjustments led to new tensions surrounding the ownership, control and contracting practices in the systems, mobilizing actions from market participants (Correlje et al, 2014).

Table 1: Empirical Perspectives of Ownership Unbundling in the Natural Gas Industry

Author (s)	Publication	Methodology	Recommendations
Bolle and Breitmoser (2006)	On the Allocative Efficiency of Ownership Unbundling	Allocative Efficiency	Findings: In general legal unbundling implies less effective regulations but it reduces the degree of market distortions caused by the difference between marginal costs and average cost (the regulated price of network usage). Legal unbundling leads to lower customer prices than ownership unbundling in most relevant markets. Recommendations: it remains debatable when and where ownership unbundling should be implemented.
Griwitsch and Stonzik (2009)	Ownership Unbundling of Gas Transmission Networks – Empirical Evidence	Empirical evaluation using dynamic estimators of GMM and LS-DVC.	Findings: Ownership unbundling seems to have any significant effect on retail prices. Countries with Third Party Access (TPA) have higher natural gas prices than others and this is even higher in the long-run. A larger share of publicly owned companies reduces natural gas retail prices. Prices raise with the concentration of the wholesale market. The concentration of natural gas services tends to reduce retail prices.

			Recommendations: it is noted that, no further separation of the different stages of the natural gas value chain.
Pollitt, M. (2008)	The arguments for and against ownership unbundling of energy transmission networks	Theoretical and empirical studies	Findings: the theoretical cost and benefit of ownership unbundling are generally positive. Ownership unbundling of transmission is a key part of energy sector reform in the most successful reform jurisdictions.
Pollitt, M. (2007)	Vertical unbundling in the EU Electricity Sector	Econometric evidence	Findings: vertical unbundling of transmission networks is necessary to promote infrastructure investments, fair network access and market transparency. Recommendation: Implementing ownership unbundling is worth it.
Haucap, J. (2007)	The Cost and Benefits of Ownership Unbundling.		Findings: Ownership unbundling sharply infringes on private property rights. Ownership unbundling in the gas industry is much weaker. It is not clear how unbundling gas network could affect competition in gas production. Substantial mark-up problems may result from gas network vertical separation.
Van Koten and Ostmann (2008)	The unbundling regime for electricity utilities in the EU: A case of legislative and regulatory capture	Theoretical and empirical observations.	Findings: Older EU countries which are perceived to be more corrupt are indeed more likely to apply weaker forms of unbundling.
Gugler et al (2013)	Ownership unbundling and investment in electricity markets – A cross country study.	A dynamic panel regression model	Findings: generally, regulations that affect only the market directly, like the establishment of a wholesale market or free choice of suppliers increases aggregate investment. Regulation, however, that adversely affects the incumbent directly, like ownership unbundling, decreases investment spending. That ownership unbundling significantly reduces aggregate investment in the electricity industry.

Source: Author's Construction (2020).

From the above theoretical and empirical discussions, Unbundling is usually preceded by an independent system operator, independent of generation (Pollitt, 2008) and when this is not properly done, there are some problems. Though there are few cases of successful ownership unbundling implementation (UK and USA), the challenges from vertical integration are however more enormous resulting in a conflict of interest and inter alia in distorted investment incentives compared to when unbundling is implemented.

Independent System Operators (ISO) seems to solve the problem of non-discriminatory access but not investment adequacy. Making transmission asset ownership separate from generation ownership improves incentives for market expansion and deepening, and may create the potential of excessive expansion if regulations are weak. Unbundling of gas transmission networks is a key feature of jurisdictions with the most successful energy reforms and it is

associated with competitive wholesale and retail markets and effective regulation of monopoly networks and the process is likely to be successful in promoting competition in the gas market (Pollitt, 2008).

Implementing ownership unbundling in gas transmission is costly in terms of transaction cost of separation. However, the benefits in terms of lower prices and costs, higher investments, increased cost responsiveness, and lower corruption seem to be worth it (Pollitt, 2007). It is, however, an illusion to believe that ownership unbundling would be bringing in any benefits as soon as been implemented (Haucap, 2007).

4.0. Discussion

Two segments of the natural gas industry were traditionally recognized in Ghana mainly: Upstream and Downstream. However, over the past ten years, up from the start of the Jubilee field production there have been infrastructure investments in the midstream thus in the construction of the Gas Processing Plant, transmission pipelines, Offshore Receiving Facilities (ORF) and the Floating Storage Regasification Facilities (FSRU) constituting the midstream. The current state of the natural gas industry in Ghana includes the upstream, midstream and downstream as defined in major natural gas industries.

Apart from upstream production of natural gas which is dominated by the IOCs the rest of the other players are state entities: GNPC, GNGC, and VRA, by these arrangements the current structure of the natural gas industry in Ghana is a state-owned vertically integrated monopoly, with GNPC leading the integration policy agenda.

4.1. Vertically Integrated Activities of GNPC

GNPC is the state partner in all upstream petroleum agreements and according to the upstream petroleum regulations and the Model Petroleum Agreements (MPA), GNPC is mandated to act as the aggregator of all upstream produced associated natural gas with the vision of facilitating midstream and downstream commercialization activities and curb flaring. Due to the monetization of associated natural gas, severe shortage of natural gas supplies from Nigeria leading to a stressed natural gas demand and a viable downstream natural gas market, non-associated natural gas exploration and production activities where encouraged leading to the development of the Sankofa Gas Fields and the subsequent development of other associated natural gas fields.

Under the proposed vertically integrated model, GNPC is to act as the aggregator of associated and the off-taker of non-associated natural gas upstream. GNPC is to be a single purchaser and owner of natural gas upstream. Why a GNPC vertically integrated structure? As stated in the Contestable Market theory by Baumol et al (1981) when it is economically efficient for one company to sufficiently meet the conditions of the market and Kwoka (2002) at a cost-effective and more efficient way, it is better to structure the market as vertically integrated. The Ministry of Petroleum and GNPC justified the reasons for a GNPC vertical integration as follows:

1. To control the supply of raw gas so that state-owned companies such Ghana National Gas Company, the existing GPP operator can survive as a viable business: Energy Commission hinted that there is the possibility of GNGC running out of business if

there is a private competitor of natural gas processing from any of the IOCs (possibly ENI) and there are chances that GNGC would be out-competed for gas processing and that can lead to an emanate collapse of the company. So there was the desire to protect the collapse of state-owned entities and the control of the supply of raw gas.

2. Rational/Harmonize Gas Pricing: domestically produced natural gas in Ghana comes from two streams; associated and non-associated gas. With a shared cost recovery with crude oil for associated gas and full cost recovery for non-associated gas, they differ in the final pricing. As summarized by the Energy Commission:

“Associated gas is cheap, and non-associated gas is more expensive and the issue is, how to provide a uniform price for both gases to the market”

Having GNPC as the aggregator of upstream natural gas for both associated and non-associated gas, the problem of price disparity is solved. GNPC will purchase both streams of natural gas into a basket and provide a single gas price to downstream buyers. In order to prevent the transfer of the uneven pricing to the market, there is a need for a single upstream buyer.

3. Easing the completion of gas purchase contracts: historically the electricity industry has not been able to pay for the gas it’s consuming from Nigeria (WAGPCo). For the new natural gas purchase contracts, as a risk-mitigating measure, IOCs are requesting securities and risk guarantees from the main downstream gas consumer in Ghana thus VRA. VRA’s balance sheets are not bankable because the wholesale buyer of electricity, Electricity Company of Ghana (ECG) is not paying for over 60% of the power purchased. This has led to VRA owing Nigeria-Gas (N-Gas) (the gas shipper) and N-Gas owing WAGPCo (the pipeline service providers) which is the main financial/economic reason why Nigerian natural gas supplies are inadequate and unreliable.

The resultant effect of this cascading debt is that new gas purchase agreements are risky with VRA and the need for alternative off-takers of the upstream gas. For the bankability of the Sankofa Gas Project, for instance, VRA became a non-credible party to new gas purchase agreements and the Government of Ghana had to rely on GNPC as the ultimate state institution with the right balance sheet, bankability, and credibility for gas purchases and to provide all the securities which may be called upon when the value chain fails to pay. This is summarized by Energy Commission as;

“...having GNPC step in with oil reserves will reduce the security requirements for some of these projects and it is easier for some of these contracts to be signed and then GNPC don’t have to put up cash upfront for securitization because future revenues from oil will provide the necessary security for their agreements”

The implication of not allowing the natural gas industry value chain to pay for itself is not sustainable to the energy sector in Ghana in the long-run. Not solving the inefficiencies in VRA and ECG and transferring that risk to GNPC is only temporary with many more implications for GNPC and the natural gas industry in the long-run. Meaning that GNPC will still be in the business of supplying VRA gas with the risk of not receiving payments and risking the whole natural gas value chain in the long-run.

4. Credible Customers: Upstream producers of gas require credible purchasers to sign long-term contracts before production, companies that can provide the right

commercial arrangements and right securities to ensure that gas is sold to the right credible customers. This is to ensure that, the upstream operators get paid so as to continue exploration and production of gas resources. Typically natural gas producers would want to see a good balance sheet and securitization is required sometimes six months in advanced payments in the forms of Letters of Credit and Advanced Payment Invoices, and GNPC has the ability to serve as a credible customer.

Providing financial guarantees and securitization became the most enduring reason GNPC is allowed to play the role of the upstream natural gas aggregator especially when the World Bank was to provide the partial political risk and sovereign risk guarantees for the development of the Sankofa Gas Project (SGP). This required a credible off-taker for the gas and GNPC proved to be the most credible Government institution in the energy value chain and also a partner to the SGP.

5. To ensure the security of supply of energy (natural gas) in the country: GNPC noted that, their role as the national gas aggregator is mainly to ensure that the natural gas industry develops in a way that is suitable to the economic development needs of Ghana in ensuring energy security. It is this objective that shaped the form and nature of the natural gas agreements and how associated natural gas should be treated in the Model Petroleum Agreement.

GNPC is to provide the technical and financial expertise to lead in the development and monetization of natural gas resources in Ghana. IOC's were initially not interested in investing in midstream infrastructure such as the GPP and transmission pipelines and were actually flaring the associated natural gas to the detriment of downstream power plants requirements. The Government of Ghana had to secure a China Development Bank loan of US\$3billion and investing US\$1billion in midstream natural gas infrastructure to provide alternative fuel to LCO to ensure fuel security by relying on domestically produced sources.

As the national aggregators of natural gas GNPC are presently involved in the development of LNG in the country to diversify the supply sources of natural gas into the country. These are all efforts to ensure adequate natural gas supplies to meet the increasing gas demand for power production and to meet the energy security requirements.

And finally, a justification for state control of the natural gas industry in Ghana is linked to the security of energy supply and ensuring energy security in the country, as the private sector does not consider investing in the midstream segment as a viable business option. The Government intends to build a robust and de-risk the system before diversifying. Operating a vertically integrated state monopoly under GNPC is considered as a government policy.

This argument, however, raised a fundamental flaw in operating the natural gas industry as a vertically integrated model and a state monopoly. As Juris (1998) noted that a vertically integrated utility often lacks the flexibility required in a dynamic market environment and regulation is often insufficient to induce efficient operations and governments seek to look for alternatives market models with potential for cost savings. Lu et al (2016) further noted that to ensure natural gas supply security is to diversify

supply sources from a single supplier in this case and this will improve the system capability of maintaining the integrity and ability to resist disturbances.

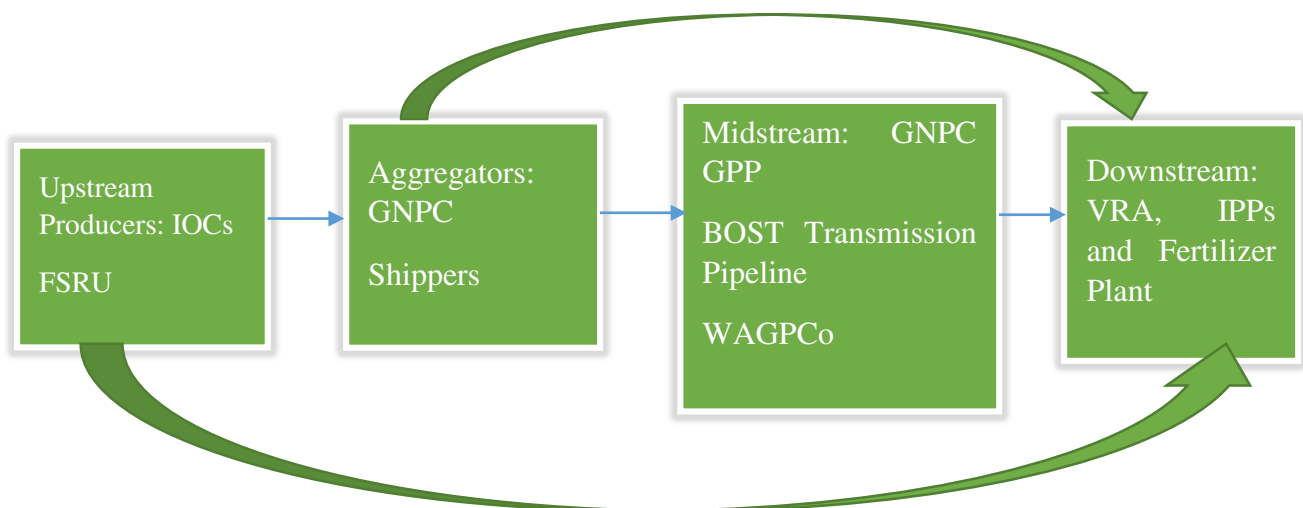
6. The Ministry of Petroleum succinctly stated that, GNPC been the national natural gas aggregator is to be able to provide technical and logistical handling of the gas infrastructure, issues of swapping of gas between the two thermal plants locations (East and West) can be handled much easier.

4.2.0. Unbundling the Natural Gas Industry in Ghana

Contrary to all the reasons for structuring the natural gas industry as vertically integrated under GNPC the national gas aggregator and the benefits to both the government of Ghana and to the stability of the natural gas industry, ENI-Ghana and the Energy Commission argues for the liberalization of the natural gas industry and unbundling the role of GNPC as vertically integrated and the single gas aggregator.

Upstream gas supply and aggregation should be liberalized to encourage private participation. This will also encourage downstream consumers to be able to arrange for their own gas and this in the long-run will make the value chain efficient. This will also diversify and promote multiple sources of natural gas into the country and ensure more energy security as compared to having a single gas supplier/purchaser and eliminate the risk of GNPC failure bringing the whole natural gas value chain to a halt in the long-run. As Gugler et al, (2013) recounted, unbundling, an independent transmission operator (ITO) is seen as more appropriate to stimulating competition, triggering investments and accelerate the evolution towards competition. The new industry structure as proposed by ENI-Ghana and Energy Commission will look like the figure below.

Figure 2: Unbundled Structure of the Natural Gas Industry in Ghana



Source: Adopted from Weijermars (2010)

From the figure above; there will still be several IOCs producing natural gas upstream. There will also be the FSRU as an LNG regasification facility available. GNPC will still be the

aggregators of both associated and non-associated natural gas from the IOCs if it is competitive for them. Shippers and downstream consumers can access the FSRU. IOCs and shippers can directly deal with downstream consumers without GNPC and VRA, and IOCs and Shipper can also invest in thermal power plants as IPPs without VRA. GNGC GPP will still be available to process all associated natural gas but their transmission pipeline will be given to BOST to operate as the NGTU license holder, with WAGPCo importing Nigerian natural gas.

From the above-proposed structure, there will be three outcomes that will become emanate; breaking the vertical integration of GNPC, unbundling natural gas transmission services and diversifying downstream natural gas consumption. And these two contrasting viewpoints advocated in the natural gas industry are leading the debate in structuring the natural gas industry in Ghana. The emerging debate on identifying the best-fit industry structure for the natural gas industry emerges as whether to proceed with the existing vertically integrated structure as recommended in the Gas Master Plan (2015) or to unbundle (Glachant et al, 2014; Andrade, 2014; and Weijermars, 2012; von Hirschhausen, 2008).

4.2.1. Scenario One: Vertical Integration of the Natural Gas Industry in Ghana

Under this scenario of which the Ministry of Petroleum, GNPC, and GNGC are proponents: GNPC will be the lead company which will be the owners of all domestically produced gas, acting as the national gas aggregator upstream, owns all the midstream and downstream natural gas industry infrastructure and be responsible for taking natural gas from upstream to the final consumers, Glachant et al (2014) noted that, this structure is a typical early-stage situation and at the early stages of developing a gas industry, where there is one gas supply source and one gas consumer (ie that's when Jubilee field was the only gas field and VRA the only downstream gas receiver).

There are currently four sources of gas (Jubilee, Greater Jubilee, TEN and SGP) led by two IOCs (Tullow and ENI-Ghana). However, under the vertically integrated structure, GNPC will be the aggregator of all these gas sources upstream and supplying associated natural gas to GNGC GPP which is a GNPC subsidiary, GNPC can then deliver upstream natural gas to either East (Tema Power Plant Enclave or West (Takoradi-Aboadzi Power Plant Enclaves).

A vertical integrated natural gas industry structure will promote economies of coordination among the vertical stages of production (Kwoka, 2002) and based on Baumul et al (1981) theory if it possible for a single firm to produce an industry's outputs at marginal cost and decreasing average cost described as economies of scale and scope it is advisable for that industry to assume a vertically integrated structure. Vertical integration promotes an overall cost reduction and it is associated with smaller operations and maintenance costs, lower per unit transmission cost reflecting greater coordination of production and transportation decisions (Kwoka, 2002). Vertical integration is proposed to be associated with cost savings and has been a central argument from GNPC.

For the case of Ghana, GNPC is the de facto national oil company signing upstream oil and gas contracts with all IOCs. GNPC is a partner to the Jubilee, TEN and Sankofa Gas Projects and is the owner of the first 200BCF of associated natural gas from the Jubilee fields. With a credible set of financial guarantees, GNPC is set to buy TEN and Sankofa Gas using revenues

from the share of GNPC crude oil sales from the other fields as financial guarantees to provide securities in gas sales contractual agreements. By virtue of the contractual arrangements upstream GNPC is assigned the role of a national natural gas aggregator by the Ministry of Petroleum but will this translate into lower cost savings and economies of scale and scope?

In financial terms: associated and non-associated natural gas is produced upstream in Ghana at different Capital Expenditure (CAPEX) and Operating Expenditure (OPEX) and sometimes for associated natural gas at a negligible cost. Associated natural gas in particular from a crude oil production field, wellhead associated natural gas prices are US\$2.8/mmbtu as compared to non-associated natural gas wellhead price of US\$9.8/mmntu. The disparity between the prices is a concern for the upstream suppliers of natural gas and the fact that the same price disparity will be transferred to the downstream consumer. The role of GNPC as an upstream aggregator is to buy both streams of gas and give a single average gas price to be supplied to the GPP and the transmission pipeline and to the final consumer. In this case allowing GNPC be a vertically integrated company will provide downstream gas consumers a single and unified natural gas price which maybe lower compared to two separate prices.

The survival of the GPP is also dependent on the volumes of associated natural gas received from upstream to be processed into lean gas and LPG for local consumptions. The commercialization of the natural gas industry in Ghana was initiated with the construction of the GPP and the 114km transmission pipeline to receive previously flared natural gas from the Jubilee fields. The capital cost of these infrastructures was secured from the Chinese Development Bank (CDB) loan and paying back the loan will require the viability both the GPP and the 114km pipeline and therefore keen control of the industry structure and the supply of associated natural gas.

The lean gas supplied from the GPP to the thermal plants operated by the Volta River Authority (VRA) has not received payments since the operation of the GPP. The GPP only depends on the sale of LPG for its survival. GNPC and the Ministry of Finance and Economic Planning, have commenced the repayment of the CDB loan until GNGC is capable of meeting its financial obligations and VRA payments for the receipt of lean gas. As a result, the Ministry of Finance and Economic Planning in the 2015 financial statement presented to the parliament of Ghana reported the takeover of GNGC by GNPC and was quoted as:

“The consolidation of GNPC and GNGC will make it possible to enhance a more integrated management and continued financing of projects in the oil and gas enclave and will ease the conditions that investors impose for the national gas aggregator (GNPC) and start financing projects in the oil and gas enclave immediately” (Finance Minister Seth Terkper, 2015 Financial Statement presented to the Parliament of Ghana) (Ministry of Petroleum, 2015).

GNPC will then act as the national gas aggregator, controls the GPP and the 114km transmission pipeline and operate as a vertically integrated company as a result of the financial reasons stated above. Kwoka (2002) however raises a further question that focuses on whether cost-effectiveness and economics due from vertical integration can be achieved by other natural gas industry structural models? This leads to the consideration of scenario two: Unbundling the GNPC Vertical Integration structure. And the next alternative of structuring should,

therefore, be able to capture the economies of vertical coordination and provide additional benefits of cost-saving as compared to vertical integration (Kwoka, 2002).

4.2.2.0. Scenario Two: Unbundling the GNPC Vertically Integrated Structure

Unbundling the activities of GNPC; under this scenario, the natural gas supply business is separated from pipeline transmission, distribution (Juris, 1998), and the GPP. Unbundling creates a level playing field for all participants in the natural gas industry, facilitates the development of a large number of suppliers that purchase natural gas in the wholesale market, resell downstream using the GPP, transmission and distribution pipeline services (Juris, 1998). The main advantages of unbundling include; fewer incentives/opportunities for discrimination; fewer incentives/opportunities for cross-subsiding and; more effective and efficient regulation (Tonjes, 2005). Unbundling is cheaper when a vertically integrated system is separated (Brunekreeft, 2015). Legal and ownership unbundling will be considered in this scenario.

4.2.2.1. Legal unbundling in the natural gas industry in Ghana

The case of GNPC and GNGC in Ghana is an example of legal unbundling, GNPC is to take-over GNGC but GNGC will operate at arm's length, separate from GNPC, having its own Chief Executive Officer (CEO), board and being autonomous. And as noted by the Minister for Finance and Economic Planning, the reasons for GNPC takeover of GNGC is financial and building an integrated natural gas industry. What does the takeover of GNGC by GNPC mean to the structure of the natural gas industry in Ghana? GNPC will be both the natural gas owner and the infrastructure owners as an upstream natural gas aggregator, the GPP and the GNGC transmission pipeline owners, therefore, GNPC will operate as a vertically integrated company.

Further, what this means is that the existing downstream natural gas price of an average of US\$8.7/mmbtu will still apply to natural gas prices which is expensive for a nascent natural gas industry under vertical integration which is the same as legal unbundling. Because GNPC and GNGC will still be operating as business as usual. However, if upstream natural gas production, supply and LNG importation are separated from the transmission pipeline network, upstream natural gas prices are most likely to reduce due to competition and both the GPP and transmission pipeline tariffs are as well likely to reduce to result in a lower downstream natural gas price.

Is legal unbundling beneficial to reducing the downstream prices of natural gas in Ghana? Legal unbundling will keep the current structure of GNPC aggregating upstream natural gas, maintains their position as the asset owner for the GPP and the transmission pipeline legally but only operating separately which is not enough to bring in the needed competition required to bring down prices. This means that even if the upstream gas supply is competitive, the other companies will still have to deal with the dominant position of GNPC in infrastructure access.

4.2.2.2. Ownership unbundling in the natural gas industry in Ghana

Ownership unbundling will completely separate the activities of GNPC from GNGC, and this requires the further breaking-down of GNGC to being the operators of the GPP and relinquishing the transmission pipeline to BOST as the Natural Gas Transmission Utility (NGTU). Ownership unbundling will mean that upstream natural supply will be competitive,

the GPP and the transmission pipeline will operate on open access and non-discriminatory basis. The role of GNPC as national aggregator upstream can still continue for its role in contractual agreements in all upstream oil and gas production fields, and providing financial guarantees for gas projects and for price harmonization, but its role as the only upstream natural gas owner for domestically produced and imported LNG will be truncated so that, the upstream natural gas supply and production segment will be open to competition. And this is the natural gas industry structure proposed by the Energy Commission, just like the electricity industry structure in Ghana. Where there are several producers/generators, an independent transmission network operator, proposed distributors and diversified downstream consumers.

5.0. Conclusion and Policy Recommendations

The aim of this paper is to examine the structure of the nascent natural gas industry in Ghana, as they exist two views among industry players as to the best-fit industry structure appropriate for Ghana. A state-owned vertically integrated structure is the current structure with GNPC leading the chain of upstream gas ownership, midstream infrastructure to final gas delivery to downstream consumers. Gas price harmonization, easing contractual agreements, maintaining the survival of GNGC, and energy security reasons are among the policy factors considered to operate a state-owned vertically integrated structure. And from the two scenarios of the natural gas industry structural models discussed it is much more appropriate to unbundle infrastructure ownership from natural gas supply. It is recommended for policymakers to maintain the aggregating role of GNPC, unbundle infrastructure ownership from upstream gas owners thus the GPP and GNGC transmission pipeline, introduce an independent entity such as BOST to operate the GNGC transmission pipeline as the NGTU on open access and non-discriminatory basis and allow IPPs equal access to source for their own natural gas. Further studies are required to access the econometric implications of the GNPC vertical integration model in Ghana.

Appendix

Interviews

1. GNPC Interview 2016
2. Ministry of Petroleum Interview 2016
3. Energy Commission Interview 2016
4. Ghana National Gas Company Interview 2016
5. BOST Interview 2016
6. Petroleum Commission Interview 2016
7. Ghana National Petroleum Commission Interview 2016
8. PURC Interview 2016
9. Volta River Authority Interview 2016
10. ENI-Ghana Interview 2016
11. WAGPCo Interview 2016
12. TICO Interview 2016

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