# ESTIMATING THE EFFECTS OF THE DEVELOPMENT OF THE OIL AND GAS SECTOR ON GROWTH AND JOBS IN GHANA (2015–30): A MODELLING AND VALUE CHAIN ANALYSIS

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**Estimating the Effects of the Development of the Oil and Gas Sector on Growth and Jobs in Ghana (2015–30): A Modelling and Value Chain Analysis.**

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**Redacted Version**

1. The Executive Summary and report of the Evaluation entitled *'Estimating the Effects of the Development of the Oil and Gas Sector on Growth and Jobs in Ghana (2015–30): A Modelling and Value Chain Analysis'* has now been redacted for public disclosure in accordance with IFC's 2012 Access to Information Policy, following the Procedure for Development, Management and Disclosure of IFC Evaluations effective on January 20, 2016.

2. The attached redacted version reflects the following adjustments:

- Redaction of sensitive or confidential information related to financial and proprietary information shared by and used with the consent of IFC clients (e.g. revenues and profits). This information was originally used in the estimations of economic effects of specific investments.

3. Questions on this document should be addressed to Evgenia Shumilkina (eshumilkina@ifc.org) and Miguel Angel Rebolledo Dellepiane (mrebolledo@ifc.org).

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| bcf | billion cubic feet |
| BDCs | bulk distribution companies |
| bopd | barrels of oil per day |
| BOST | bulk oil storage and transportation company |
| CAPEX | capital expenditure |
| CGE | computable general equilibrium |
| E&P | exploration and production |
| EC | Energy Commission |
| ECG | Electricity Company of Ghana |
| EDC | Enterprise Development Center |
| EIA | Energy Information Administration |
| EIS | Environmental Impact Statement |
| FEED | front end engineering design |
| FID | final investment decision |
| FPSO | floating production storage and offloading |
| FTE | full-time equivalent |
| GDP | gross domestic product |
| GMP | Ghana Gas Master Plan |
| GNGC | Ghana National Gas Company |
| GNPC | Ghana National Petroleum Corporation |
| HAZOP | hazard and operability studies |
| IBRD | International Bank for Reconstruction and Development |
| IDA | International Development Association |
| IEA | International Energy Agency |
| IFC | International Finance Corporation |
| IOC | international oil company |
| IPP | independent power producer |
| LCP | Local Content Plan |
| LCR | Local Content and Local Participation Regulation |
| LNG | liquefied natural gas |
| LPG | liquefied petroleum gas |
| mmboe | million barrels of oil equivalent |
| MMBtu | million British Thermal Units |
| mmcfd | million cubic feet per day |
| MMscfd | million standard cubic feet per day |
| MoEP | Ministry of Energy and Petroleum |
| MW | megawatt |
| NGL | natural gas liquid |
| OCTP | Offshore Cape Three Points |
| OMCs | oil marketing companies |

| | |
|---|---|
| PC | Petroleum Commission |
| PoD | Plan of Development |
| PURC | Public Utilities Regulatory Commission |
| RBL | reserve-based lending |
| SAM | Social Accounting Matrix |
| SCD | Supply Chain Development Program |
| SME | small and medium enterprises |
| TEN | Tweneboa, Enyenra, and Ntomme (fields) |
| TOR | Tema Oil Refinery |
| VRA | Volta River Authority |
| WAGP | West African Gas Pipeline |

# 1. EXECUTIVE SUMMARY

## Introduction

The recent oil and gas discoveries in Ghana present a unique opportunity to boost economic growth and increase prosperity. These discoveries created high expectations for a significant positive impact on the Ghanaian economy and people through job creation, particularly through small and medium enterprises (SMEs). However, among resource-rich countries there are examples of both successes and failures in the utilization of resource-generated wealth. The impact on the Ghanaian economy and society will depend on the policies implemented moving forward, including those associated with the use of the government oil revenues. This study discusses impacts observed to date, potential implications, and likely growth scenarios from 2015 to 2030 linked to several policy choices.

Ghana has shown mixed macroeconomic performance in recent years, with significant shocks being amplified by policy slippages and resulting external and domestic imbalances. Growth in 2016 was 3.5 percent, the lowest level in two decades. A recovery of growth is expected in 2017–18, due to an increase in oil production, declining inflation, and lower imbalances, if the right policies are implemented. Following a sizeable fiscal slippage in 2016, the authorities are targeting a significant fiscal consolidation in 2017, which will require sustained revenue collections and spending controls. Inflation has continued to decline, and the exchange rate has been broadly stable. The external position is improving, supported by strong foreign investor participation in the domestic debt market.

The government engaged with international companies in the exploration, construction and operation phases of the Jubilee; Tweneboa, Enyenra, and Ntomme (TEN); and Sankofa fields. The World Bank Group supported these developments by engaging strategically with the Ghanaian government and the private sector. The first oil and gas discovery was the Jubilee field in 2007, which entered operation in 2010. The TEN field was discovered in 2009 and entered operation in 2016. Finally, the Sankofa field was discovered in 2011 and entered operation in 2017. Proven oil reserves are estimated at 1.1 billion barrels, while proven gas reserves are estimated at 2.1 trillion cubic feet. In the long term, oil production is projected to peak at 236,290 barrels per day, and gas production is expected to average 323.7 million cubic feet per day. As local content regulation has been enforced only since early 2014, most of the local content in the upstream value chain until then had been driven mainly by market forces.

The overarching question that the study seeks to answer is about the current and potential future outcomes for Ghana derived from (i) the development of the oil and gas fields, (ii) the increased market share of gas-fired power generation, and (iii) the development of the upstream oil-and-gas value chain. The building blocks of the methodological approach are the following: (i) Computable general equilibrium modelling (GEM-E3-G) that estimates the direct, indirect, and induced effects over the period 2015–30; (ii) value chain analysis based both in quantitative and qualitative primary and secondary data; and (iii) a survey of SMEs interested in delivering goods and services to the upstream value chain.

## Findings at the Macro Level

The immediate effect of the development of the oil and gas fields was the diversification of exports from two commodities (gold and cocoa) to three, with the addition of crude oil. Currently, gold, cocoa, and crude oil account for about 70 percent of total exports; therefore, the economy is still exposed to commodity-price variability. However, the low level of industrialization of the country leads to increased imports that span a wide range of products and capital goods.

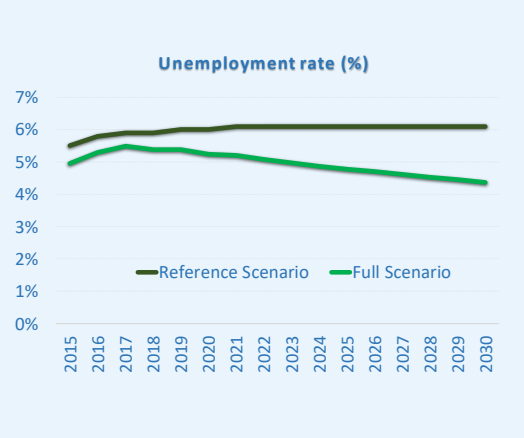
The unreliability of power supply undermines Ghana’s economic growth. Although Ghana’s installed capacity of 4,275 megawatts (roughly 40 percent hydropower and 60 percent thermal)

is higher than the peak demand, it failed to meet electricity demand in 2014 and 2015. This was mainly due to lower water levels in the reservoirs and insufficient and intermittent gas flow coming from Nigeria through the West African Gas Pipeline. Moreover, the government has yet to establish the necessary framework to encourage private sector investment in the power sector and to fix the weak financial situation of the state-owned utilities.

By comparing one scenario with its "counterfactual," the study estimated the potential of these discoveries to boost economic growth and generate jobs in 2015–30. The scenario (Full Scenario) assumes that the three oil and gas fields become fully operational. This includes the completion of the construction of the three fields, the use of natural gas to generate electricity (replacing currently used liquid fuels), and the use of the oil revenues to improve the country's infrastructure. The counterfactual scenario (Reference Scenario) hypothesizes a situation in which no oil and gas fields were discovered, and therefore energy needs continue to be met with gas and electricity imports.

According to the Full Scenario estimates, the multiplier effect of the development of the oil and gas sector would be much larger on gross domestic product (GDP) than on employment. As oil revenues are used to upgrade infrastructure, both labor productivity and competitiveness of the economy increase. As the productivity increases, income increases but fewer labor hours are needed per unit of output. For example, the GDP is estimated to grow 6.4 percent annually in the Full Scenario (2015–30) and 6.07 percent annually in the Reference Scenario (that is, 0.33 percentage points higher annually). The higher estimated effect on growth in the Full Scenario is underpinned by an additional 5.3 percent growth in exports (mainly oil and services), 2.8 percent growth in investment, 4 percent growth in household consumption, and 3 percent growth in imports. Moreover, oil government revenues are estimated in US$21 billion and GDP is expected to grow by about an additional US$75 billion (almost 3.5 times the size of oil government revenues). The economy seems to ultimately benefit by increased productivity and competitiveness. The estimated effect of the construction phase is relatively smaller and significant only until 2018 (as several services and capital goods are sourced overseas).

**Figure 1.1: Estimated Effects on the Overall Unemployment Rate (2015–30)**




*Source:* Estimates from the GEM-E3-G model.

The model also estimated 166,500 sustained full-time equivalent jobs added in the Full Scenario.[1] These added jobs point to a steady decrease in the unemployment rate to a value close to the natural rate of unemployment (Figure 1.1) as a consequence of the investments in the oil, gas, and power sectors as well as of the oil revenues to be received by the government. Regarding sectoral effects, the growth in the construction and energy-intensive employment is driven by the investments in infrastructure, whereas the growth changes in agriculture is driven by the increase of household income. As the improved competitiveness and productivity of the Ghanaian economy increases household income, this additional income translates to a large extent into more demand for agricultural products, thus increasing the output and income of the agriculture sector.

According to the model estimates, policies focused on expanding the physical infrastructure seem to be the most effective in the medium term, and policies focused on expanding human capital seem to be the most effective in the longer term (over 15 years). Moreover, positive effects increase when government policies are oriented toward the increase of total factor

productivity (for example, innovation and technology) and when the global level of the oil and gas commodity prices increases.

**Findings at the Upstream Oil Value Chain Level**

Local content (participation) regulation in Ghana was enforced in 2014. Most of the local content in the upstream until then was driven by market forces. However, the experience gained by the workforce and SMEs in the period prior to local content regulation helped Ghanaians to better service a more regulated local content market thereafter. Since 2014, every local and foreign contractor, subcontractor, licensee, corporation, or other allied entity carrying out oil- and gas-related activities has a responsibility to ensure local content forms a central plank of its operations.

While local content requirements are typically seen quite negatively in the foreign direct investment literature, the creation of jobs and linkages between the oil industry and the local economy are an important policy objective. To achieve this, governments are faced with the trade-off between indirectly taxing oil companies through performance requirements and directly imposing additional taxation and using the funds to promote formal job creation elsewhere in the economy. This is assuming that these additional revenues could be collected and spent wisely, which is certainly not a given. When public administration and investment management is weak, local content regulation can be an acceptable second best in sectors such as oil and gas.

As the upfront investments required to develop the oil and gas fields are significant compared to the oil revenues that the government would receive in 2015–30, any additional increase in the participation of local employment, goods, and services could potentially impact positively the economy. This should be seen in a context where the upfront investments are estimated to amount to approximately 76 percent of the total oil revenues that the government would receive. (Upfront investments were estimated in US$16 billion, and oil revenues to the government in US$21 billion). However, it should be noted that this comparison between local participation in upfront investments and government revenues is, of course, hypothetical, as it is impossible for any country to produce locally 100 percent of the goods and services demanded by such complex projects: even the most developed countries import a significant portion of the services and goods needed.

In terms of employment, the study found that limited opportunities in the oil and gas sector are available to the local workforce. This is principally due to a combination of two factors. First, the sector is knowledge and technology intensive rather than labor intensive. Second, the oil and gas sector is a recent addition to the economy; therefore, education and vocational training programs have not been in place for sufficient time to produce the type and level of skills required by the sector. However, over 80 percent of the respondents to the study's SME survey mentioned that they employ only Ghanaians, and just over half (52 percent) see a strong or very strong increase in their future employment figures, with only 11 percent seeing stagnation or reduction. Moreover, 37 percent of the survey respondents stated that they were optimistic in terms of employing more personnel as a direct result of the oil and gas sector expanding businesses in the future, with the rest stating that any future employment can be only partially attributed to the sector.

To mitigate these skill gaps, several privately and publicly funded programs were organized aiming at developing technical and safety skills of young professionals and graduates from Ghanaian institutions. Others were focused on building the capacity of local education institutions. Finally, a few company-led programs provided scholarships for Ghanaians to study overseas and/or gain hands-on experience as trainees in more developed company operations in other countries. On-the-job training includes "shadowing" expatriates who perform specialized

technical jobs, so that Ghanaians can acquire the necessary experience to meet the position's requirements when the expatriate departs and hands over the responsibility.

In terms of local supplier participation, before 2014 international companies and their suppliers procured some sector-specialized services from local suppliers such as customs clearing, local transport, lifting equipment (for example, cranes and forklifts), water, food, fuel, and travel agency services. Additionally, other nonspecialized services were provided locally, such as civil engineering, construction, metal fabrication, and welding, because these capacities had been developed by suppliers to the more seasoned mining sector and transferred to the more recent development of the oil and gas sector. After the enforcement of the local content regulations in 2014, certain goods and services were reserved for local suppliers only: for example, catering, logistics, welding and fabrication services, vessel services, and freight forwarding. Currently, the companies registered with the Petroleum Commission offer engineering and/or construction activities (33 percent); logistics and/or manpower services (27 percent); oilfield and/or equipment services (21 percent); consulting, insurance, financial, and/or legal services (12 percent); and hospitality and/or catering activities (7 percent). However, only a subset of these registered companies are actively engaged with the sector.

Testimonials obtained from the stakeholders interviewed and the SMEs surveyed indicate that most SMEs service the sector either directly, through the provision of services to international companies, or indirectly through the provision of services to foreign contractors. According to the SMEs surveyed, the share of the products and services that they sell in oil and gas upstream follow an upward trend. These SMEs were asked during the survey to report annually the proportion of goods and services that they provided to the oil and gas sector. The average percentage is larger in 2014–17 than in 2007–13, as these companies built their capacity and the mandatory local content requirements were enforced after 2014. However, the value of goods and services provided by local suppliers and produced in the country is significantly smaller than the value of contracts that they secured with the upstream sector, and it depends on the type of good and/or service provided. The SMEs providing nontradables were more likely to indicate a higher proportion of locally produced goods and services than SMEs providing tradables (equipment is typically imported by companies with over 51 percent of Ghanaian ownership). Oilfield service providers shared their assessment that the ratio of imported to domestic goods in the sector can be as high as 90:10. For example, a local supplier of subsea services chartered a vessel from a Norwegian company, and consequently 60–90 percent of its cost is spent outside the country.

Several public and private initiatives have been set up for the support of SMEs and the promotion of entrepreneurship in Ghana, some of which are specifically relevant to companies wishing to be involved in the country's oil and gas sector. The international companies operating in Ghana have supported these initiatives and have implemented their own programs to facilitate local SME participation. The major initiatives and organizations for the development of SMEs have included over time the Enterprise Development Center, the Supply Chain Development Program (SCD), the Association of Ghana Industries, Invest in Africa, and the National Board for Small Scale Industries. As an example of the impact these programs can have, the SCD program has engaged with 250 companies to date. Currently, 100 companies are actively engaged and receive training every month and 72 contracts (total value of US$18.5 million) were awarded to these companies during from 2014 to 2017.

Local suppliers to the oil and gas sector face significant constraints to growth, despite the country's relatively good business environment rankings. Ghana performed better than the regional Sub-Saharan average and regional peers in terms of ease of doing business in 2017 and improved its position compared to the previous two years. Through literature review and primary research, this study assessed the following constraints: (i) access to finance, (ii) access to business information, (iii) stringent technical and quality standards, (iv) high costs of doing

business, (v) weaknesses of current industrial policies, and (vi) the small size of the domestic oil and gas market. Moreover, the sustainability of government efforts to develop the oil and gas value chain are constrained by the limited size of these oil and gas developments. Lastly, the risks of increased cost of some local goods and services and of corruption associated with local content regulation have also been mentioned as inhibiting elements.

**Going Forward**

- Given the oil and gas windfall, the study highlights potential policy areas where the government of Ghana and the development community could collaborate moving forward. They relate to policies focused on upgrading the energy system as well as investing significantly in physical infrastructure in general.
- These policies should be complemented with policies that promote innovation and the development of human capital as a vehicle to infuse increased productivity and competitiveness in the economy. Additionally, the more the government and the development community do to improve baseline sector-specific data collection and availability, the better informed these policies would be.
- Given the relatively small scale of the Ghanaian oil and gas market, further efforts to regionally integrate it may enhance the developmental potential for SMEs development and job growth. The development community could, for example, support enhanced integration efforts with knowledge products and experiences from other regions.
- Given the recent implementation of the local content regulation, an evaluation of the impact of this regulation in two to three years could be helpful to inform policy changes. This evaluation may be enriched by benchmarking its results with the experience from other countries. This evaluation could include in its scope an assessment of how well entrepreneurial platforms link the international companies with local suppliers.
- Additionally, sector diagnostic studies identifying promising subsectors with high potential for value added and exports would support the design by the government and the development community of more relevant industrial policies for Ghana in the context of the oil and gas windfall.

**Notes**

[1] Jobs are estimated as full-time equivalent (FTE) positions on average over 2015–30. For example, if 2,000 work hours are equivalent to one FTE job and total added work hours is 200,000 in 2015–30, then the added FTE jobs are 7 (200,000 hours/15 years/2,000 hours).

# 2. MOTIVATION AND COUNTRY CONTEXT

**Motivation**

Ghana is today the 13th largest oil producer in Africa and the 47th in the world. Since 2011, production and exports of oil have contributed to Ghana reaching its highest level of gross domestic product (GDP) growth in history, making it until recently one of the fastest-growing economies in the world. Ghana currently produces 59,000 barrels of oil per day from the Jubilee field, which has reserves of about 3 billion barrels. Gas supply from the country's three resource fields is expected to help reduce power-generation costs and facilitate further expansion of electricity supply.[1] The projects are also considered important for the creation and development of a specialized local industry and professional skills base associated with the oil and gas industry.

The World Bank Group has supported the development of Ghana's three oil and gas fields with several instruments. These three oil and gas fields are the Jubilee oil field (2009); Tweneboa, Enyenra, and Ntomme (TEN) oil fields (2015); and the Sankofa gas project (2015). The International Finance Corporation (IFC) has a long-standing relationship with Ghana since the latter became a member in 1958, having committed an accumulated amount of US$3.65 billion in 104 projects across several sectors and industries.[2]

The recent discoveries of oil and gas in Ghana have the potential to boost economic growth. However, their impact will depend on the economic policies implemented, including the ones associated with the use of the additional oil and gas government revenues.

Across resource-rich countries, there is an abundance of both success and failure stories. On the one hand, the literature characterizes Indonesia as a success story because of the type of economic policies implemented by the Indonesian government (Easterling and Fox 2008). These include keeping the value of the currency rate low to help growth in export-oriented industries; dedicating oil revenues to upgrade road, irrigation, and telecommunications infrastructure, with a focus on rural areas; and promoting the development of financial intermediation.

On the other hand, the literature characterizes Venezuela as an example of resource curse, with high subsidies for oil products, overdependence on oil export revenues, diffused financial control, and patronage politics, as the national oil company spends 40 percent more on social programs than on its oil and gas operation (Venables 2016). Moreover, food production capacity declined, and the nationalization of businesses reduced the incentive to produce. Nigeria is also characterized as unsuccessful. With a history of over fifty years of oil production, Nigeria has not achieved sustainable socioeconomic development (Mähler 2010). Some of the reasons provided are internal political instability and violent conflicts, limited social and infrastructure expenditure, oil exports accounting for most of total exports, negative political economy and unsustainable energy subsidies, persistent weakness of political institutions and lack of central coordination that fuel corruption, and ineffective industrial policies.

The overarching question this study seeks to answer is the following:

> *What are the current and potential future outcomes for Ghana derived from: (i) the development of the oil and gas fields, (ii) the increased market share of gas-fired power generation, and (iii) the development of the upstream oil and gas value chain?*

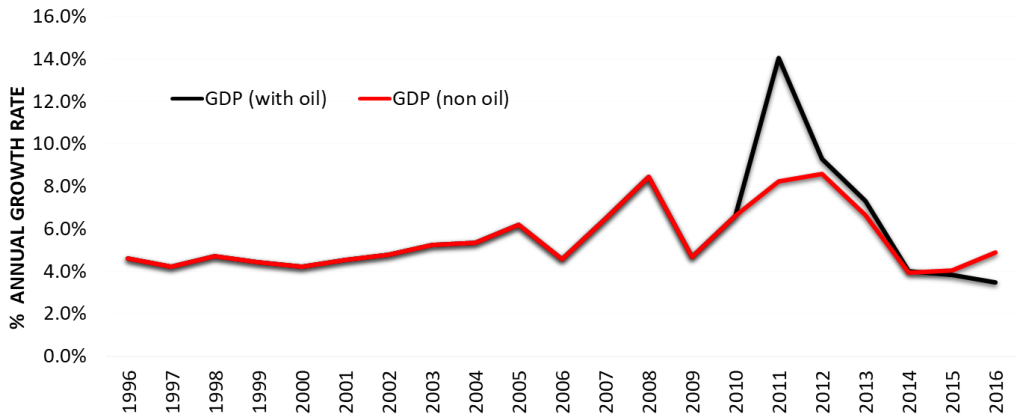
This chapter discusses aspects of the economy in order to lay the foundations for the analysis of potential outcomes from the three oil and gas developments.

## Key Macroeconomic Indicators

Ghana has shown mixed macroeconomic performance in recent years, with significant shocks being amplified by policy slippages and resulting external and domestic imbalances. Growth in 2016 was 3.5 percent, the lowest level in two decades. A recovery of growth is expected in 2017–18, owing to an increase in oil production, declining inflation, and lower imbalances if the right policies are implemented. Following a sizeable fiscal slippage in 2016, the authorities targeted a significant fiscal consolidation in 2017, which will require sustained revenue collections and spending controls. Inflation has continued to decline, and the exchange rate has been broadly stable. The external position has continued to improve, supported by strong foreign investor participation in the domestic debt market (IMF 2017).

GDP in Ghana grew at an annual average rate of 5.8 percent over the 1996–2016 period (figure 2.1). The contribution of the oil and gas fields to the economy is the main explanation for higher than usual GDP growth in 2010–14. For example, growth in 2016 dropped by 1.2 percent (from 2015) due to the damage to the turret bearing of the floating production storage and offloading vessel *Kwame Nkrumah* operating in the Jubilee field.

**Figure 2.1: GDP of Ghana, 1996–2016 (2005 US$)**



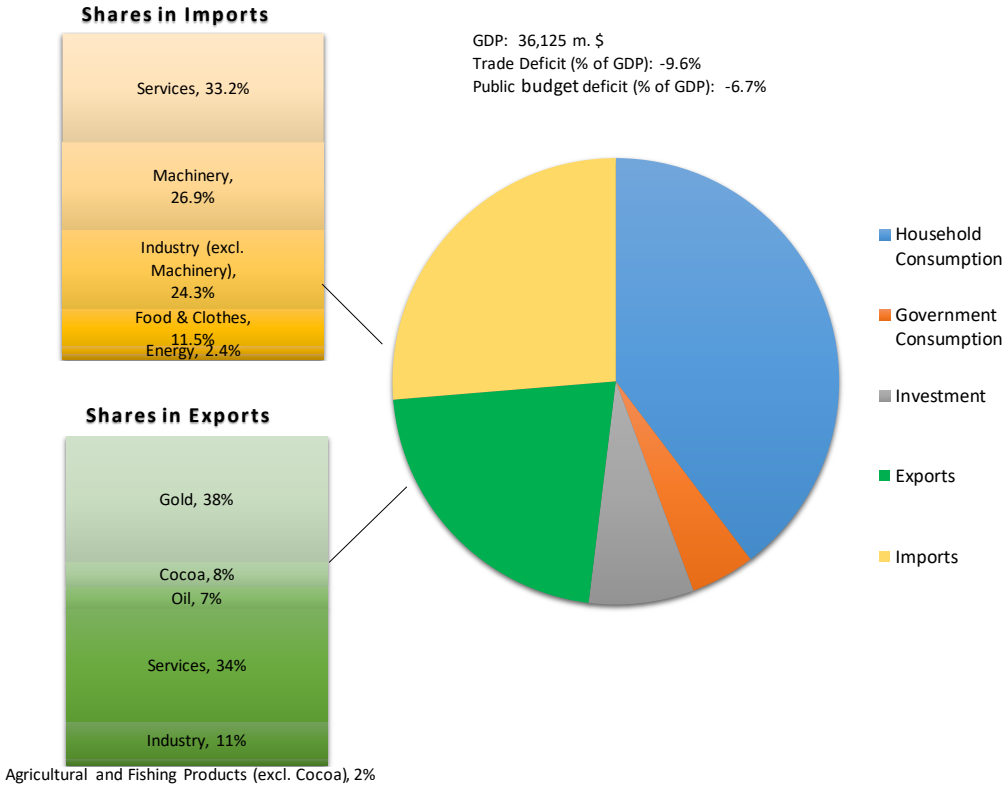

*Source:* Statistics from Ghana Statistical Service and Ghana Data Portal.

In 2016, the GDP of Ghana reached US$36.1 billion, largely dominated by household consumption (68 percent of GDP) and a trade deficit (18 percent of GDP). In terms of value added, agriculture is the largest contributor, mostly through the production of cocoa. Agriculture, construction, transport, and consumer goods account altogether for more than 50 percent of value added.

In recent years, trade openness increased with both imports and exports growing at a faster pace than GDP—trade as a percentage of GDP was 5 percent in 1995 and 50 percent in 2016.[3] The trade profile of Ghana is characterized by exports of commodities (gold and cocoa) and imports of high value-added products. The development of the oil and gas fields diversified exports to include crude oil. Currently, gold, cocoa, and crude oil account for about 70 percent of total exports, making the economy highly exposed to commodity-price variability.

Imports span a wide range of products and capital goods, which reflects the low industrialization level of Ghana.[4] More than 80 percent of transport equipment, motor vehicles, electronic equipment, and other manufacturing is imported, and about 70 percent of the cement and refined oil products are procured overseas. Almost 60 percent of the products manufactured by energy-intensive industries (iron and steel, chemicals, paper and pulp, for example) are also imported. However, imports of consumer goods and market services are rather limited.

**Figure 2.2 GDP Components in 2015**




*Source:* Based on the Ghana Social Accounting Matrix (SAM), 2015.

The public budget deficit was 6.7 percent of GDP in 2016 (table 2.1). The actual oil revenues realized were US$220 million, almost 40 percent lower than projected for the 2016 budget. The lower oil revenues contributed to the increase in the budget deficit and led to a further increase in the public debt. In 2016, Ghana's public debt represented 73 percent of its GDP, and 42 percent of tax revenues were required to service it (both interest and capital).

Ghana's population was estimated at about 26.7 million in 2015, while the labor force estimate is 11.6 million with a participation rate of about 80 percent (ILO 2015). Ghana is characterized by a low unemployment rate (5.2 percent). Approximately 45 percent of total employment is provided by the agricultural sector. The Ghanaian workforce consists mainly of unskilled labor.

**Table 2.1: Public Budget, 2016 (US$ millions)**

| | **2016** |
|---|---|
| **Total revenues** | 5,872 |
| **Of which oil-based revenues** | 220 |
| **Total expenditures** | 8,424 |
| **Deficit** | 2,553 |

*Source:* Ghana Ministry of Finance, *2018 Ghana Budget Statement and Economic Policy*.

## The Power Sector

The unreliability of power supply undermines Ghana's economic growth. This section reviews the power system in Ghana to build the foundation for analysis of the impact of the effects of the additional gas coming into the system as a consequence of the development of Jubilee, TEN,

and Sankofa. It briefly discusses the electricity sector, including power generation, grid infrastructure, energy trade, and electricity rates.

Although Ghana's installed capacity of 4,275 megawatts (MW) (roughly 40 percent hydro and 60 percent thermal) is higher than the peak demand, it failed to meet demand in 2014 and in 2015 (Oxford Business Group 2015). This was mainly due to lower water levels in the reservoirs and insufficient gas flow coming from Nigeria through the West African Gas Pipeline (WAGP). This led to the proliferation in the use of generators powered by liquid fuels, including diesel fuel and heavy fuel oil.

State-owned companies account for 88 percent of the installed generation capacity (the Volta River Authority and the Bui Power Authority), while Independent Power Producers (IPPs) account for the remaining 12 percent. IPPs include such companies as Sunon Asogli and CENIT Energy. GRIDCo is the state-owned utility responsible for transmission. Distribution is the responsibility of the Electricity Company of Ghana, serving more than 2.5 million residential customers and 1,000 companies, and of the Northern Electricity Distribution Company, serving the rest of the country.

**Box 2.1: Overview of the Ghanaian Electricity System**

- Currently, the generation deficit is covered by imported energy and by a Turkish barge docked in Tema (estimates of 300 MW—there should be a 2200 MW addition for the next 10 years).
- Volatile precipitation levels affect hydro power generation, making the system unreliable, and a significant proportion of the generation capacity is hydro.
- The latest built thermoelectric plants increased the average electricity cost (as compared with the low cost of energy produced by hydroelectric plants).
- Stated-owned utilities are highly indebted because they are not able to transfer their full cost to their consumers.
- Transmission and distribution losses are currently on the high end (roughly 28 percent).
- The government has ambitious plans to award more IPP contracts as the Sankofa gas becomes available. However, their implementation is still uncertain.

*Power Generation*

The government has yet to set the necessary framework to encourage the private sector to invest and increase the capacity of the power sector and to fix the weak financial situation of the state-owned utilities. The country's installed capacity is approximately 4,275 MW. It includes 1,580 MW in hydroelectric plants, 22.5 MW in solar plants, and the balance in thermoelectric plants. Appendix E describes in detail the installed capacity (table E.1) and outlines current knowledge about the planned capacity increase (table E.2).

In 2015 the country faced power shortages and rolling blackouts (150 days) when the growth of the economy was at the same time slowing down (Reuters 2015). The main reasons for the supply-demand mismatch were low water levels in the main reservoir of the Akosombo hydroelectric plant;[5] intermittent gas supplies coming from Nigeria; and low availability of some old thermal generation plants.

Lack of electricity affects small and medium enterprises (SMEs) and households (Forkuoh and Li 2015; World Bank 2017). Their alternative is to resort to diesel generators, but typically they cannot afford this alternative without losing competitiveness. Per the Institute of Social Science

and Economic Research (ISSER 2015), the economic cost of the unreliable power supply is estimated at between $320 and $920 million per year (Forkuoh and Li 2015). Moreover, the Wholesale Power Reliability report (PSEC and GRIDCo 2010) indicated that the cost of inadequate and unreliable power supply was between 2–6 percent of GDP, and the World Bank (Mathrani et al. 2013) estimated it at 1 percent of GDP. The International Monetary Fund (IMF 2016) also highlighted the need to fix the power sector, which has led to bad economic performance of manufacturing.

*Grid Infrastructure*

Electricity access stood at about 78 percent in 2016, placing Ghana at the forefront in the Sub-Saharan Africa region. This is attributable to the launching of the National Electrification Scheme in 1989 (IEA 2014). However, transmission losses are about 4.7 percent and distribution losses are about 23.5 percent (both technical and commercial losses). This is high compared to the 8.2 percent global average of transmission and distribution losses, the European Union level average of 6.4 percent, and Sub-Saharan average of 11.7 percent.[6]

*Electricity Trade*

Although until 2005 Ghana was a net importer of electricity, more recently the country became a net electricity exporter (table 2.2). However, the net export balance has been decreasing since the 2010 peak of 930 gigawatt hours. This is a consequence of diminishing exports and higher imports over the period. The electricity trade balance is affected by the variable energy production of the hydroelectric plants owned by the Volta River Authority, which suffer from increasing drought periods. The primary electricity trading partners of Ghana are the Ivory Coast on the West, and Togo and Benin on the East. These four countries are interconnected by transmission lines.

**Table 2.2: Foreign Electricity Trade (gigawatt hours)**

| Year | 2000 | 2002 | 2004 | 2005 | 2006 | 2008 | 2010 | 2012 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Import** | 864 | 1146 | 878 | 815 | 629 | 275 | 106 | 128 | 51 | 223 |
| **Export** | 392 | 612 | 665 | 639 | 754 | 538 | 1036 | 667 | 522 | 552 |
| **Net import** | 472 | 534 | 213 | 176 | -125 | -263 | -930 | -539 | -471 | -329 |

*Source:* Diawuo and Kaminski 2017; IEA 2017.

*Electricity Rates*

Ghana's electricity market has undergone significant restructuring and reforms, including the ongoing unbundling of assets and the opportunity for increased private sector participation through IPPs. Electricity rates have increased recently, in order to make them more cost reflective (table 2.3).

The tariff framework defined by Public Utility Regulatory Commission (PURC) makes residential consumers pay less than nonresidential ones. Additionally, lower consumption leads to a lower electricity rate paid. There are effectively cross-subsidies from nonresidential consumers and from the wealthier residential consumers to the poorer residential consumers. Overall, electricity rates do not fully reflect generation, transmission, and distribution costs, as highlighted in Pueyo et al. (2016).

**Table 2.3: Electricity Rates**

| Residential consumption (kWh) | Rate (Ghanaian pesewa) | Rate (2014 US$) |
|---|---|---|
| **0–50** | 20.5 | 0.06 |
| **51–300** | 41.2 | 0.12 |
| **301–600** | 53.5 | 0.16 |
| **601-** | 59.4 | 0.17 |
| **Service charge (per month)** | 387.5 | 1.14 |
| **Nonresidential consumption (kWh)** | **Rate (Ghanaian pesewa)** | **Rate (2014 US$)** |
| **0–300** | 59.2 | 0.17 |
| **301–600** | 63.1 | 0.18 |
| **601-** | 99.5 | 0.29 |
| **Service charge (per month)** | 645.9 | 1.89 |

*Source:* Ghanaian Public Utilities Regulatory Commission, http://www.purc.com.gh/purc/sites/default/files/4th_qtr_aaf_2014.pdf.

*Notes:* kWh = kilowatt hour; a pesewa is a Ghanaian monetary unit worth one hundredth of a cedi.

Ghana, Ivory Coast, and Nigeria (the West Sub-Saharan region) are among the countries with the highest average cost of electricity generation in Africa (about US$140 per megawatt hour, MWh). The IEA World Energy Outlook has conducted a comparative assessment of grid electricity prices by end use sector in selected African countries (IEA 2014). Average generation cost in the East Sub-Saharan region (Ethiopia, Kenya, and Rwanda) stands at US$110 per MWh, while in southern parts of Africa (South Africa, Zimbabwe, and Angola) average generation cost is estimated at only US$55 per MWh in 2013. The increased generation costs in recent years reflect the addition of new thermal units that increased electricity costs (Pueyo et al. 2016). The Ghana Wholesale Electricity Market Bulletin confirms that the average generation costs for thermal power plants stands at more than US$110–120 per MWh in 2016, while hydro capacities provided electricity at an average cost of US$70–80 per MWh (Pueyo et al. 2016).

## The Oil and Gas Sector

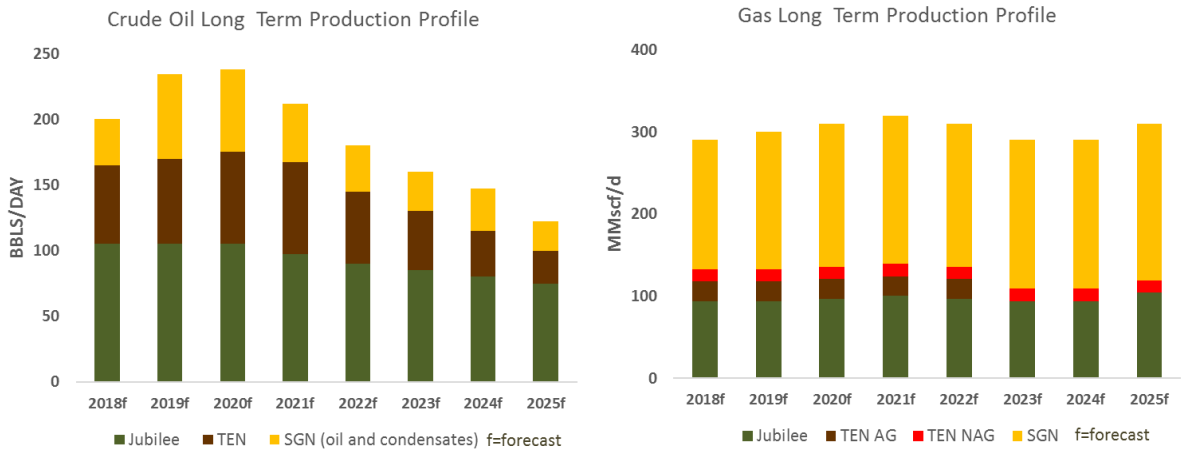
Ghana's oil and gas sector is attracting significant investments and creating expectations of further economic growth. Refined oil products are currently the second-most used form of energy, after bioenergy (mainly in the form of biomass used by households, that is, wood). Oil products account for 40 percent of primary energy supply, followed by hydropower and natural gas.

### *Oil and Gas Production*

Ghana is an emerging oil and gas producer with potential for large-scale commercial development of offshore oil and gas fields. Oil production started in December 2010. Proven oil reserves are estimated at 1.1 billion barrels, while proven gas reserves are estimated at 2.1 trillion cubic feet. In the long term, oil production is projected to peak at 236,290 barrels per day, and gas production is expected to average 323.7 million cubic feet per day (figure 2.3)[7] Currently, Ghana uses natural gas produced by the Jubilee Field and imports natural gas from Nigeria via the WAGP.

Oil companies operating in Ghana are mainly multinationals. Some of the major oil and gas companies include Tullow Ghana, Kosmos Energy, Eni, and Hess Ghana Limited. Their subcontractors include Schlumberger, Baker Hughes, Weatherford, Ocean Rig, and Technip. The number of SMEs in the sector has increased since the development of the oil and gas fields.

**Figure 2.3: Projected Production Profile: Crude Oil and Natural Gas (2018–25)**




*Source:* Ghanaian Ministry of Finance.

Note: SGN=Sankofa Gye-Nyame, AG= Associated Gas, NAG=Non-Associated Gas

*The Jubilee, TEN, and Sankofa Fields*

This section briefly describes the Jubilee, TEN, and Sankofa fields, whose development the World Bank Group supported in various ways. A more detailed description can be found in appendix G.

Jubilee Field

In 2007, two exploration wells confirmed the Jubilee Oil Field's approximately 600 million barrels of recoverable oil reserves (Tullow Oil 2017a; World Bank 2015b) and 800 billion cubic feet of associated gas resources (World Bank 2009). The oil samples showed high-quality light crude oil with low sulphur content. The field lies about 60 kilometers off the coast, at a depth of about 1,250 meters and between the license blocks Deepwater Tano and West Cape Three Points. The Jubilee discovery was the decade's largest in offshore West Africa (Kosmos n.d.) and Ghana's first oil-production project (IFC 2015). It enabled the development of the upstream and midstream of the oil and gas sector in the country, as well as for the first time the diversification of the country's exports from the traditional commodities of gold and cocoa (IFC n.d.).

Tweneboa Enyenra Ntomme (TEN) Field

TEN is Ghana's second largest field, and the second to come into production (Tullow Oil 2016). In 2009, an initial well was successfully drilled. This was followed up by a series of further successful appraisal and exploration wells, which resulted in the discovery of the TEN field (Tullow Oil 2017b). The total recoverable reserves are estimated at about 300 million barrels, with a plateau peak production of about 80,000 Barrels of oil per day (bopd) (World Bank 2015c). Moreover, both associated and nonassociated gas was found (World Bank 2013). The fields that make up TEN lie in the Deepwater Tano block, about 45 kilometers off the coast and about 20 kilometers west of Jubilee, at a depth of 1,000–2,000 meters. By adding nonassociated gas to the energy mix, the TEN field can further diversify Ghana's power sector and strengthen the country's downstream industry.

Sankofa Field

The Offshore Cape Three Points (OCTP) Integrated Oil and Gas Project includes the combined development of the Sankofa Main, Sankofa East, Gye Nyame, Sankofa East Cenomanian, and Sankofa East Campanian (Eni 2016; World Bank 2015a). The former three are nonassociated gas fields, while the latter two are oil fields. The development of the fields started in January 2015. The fields are located within the OCTP block in the Tano Basin, at water depths ranging

from 600 to 1,000 meters and lie approximately 60 kilometers off the coast of Ghana. The offshore fields are estimated to hold approximately 1.5 trillion cubic feet of gas and approximately 500 million barrels of oil. The reserves are expected to continuously feed Ghana's thermal power plants for more than 20 years. Oil production from the project commenced in May 2017 and is expected to peak at 80,000 bopd in 2019. Gas production is expected to start in mid-2018, with a daily production capacity of 170 million cubic feet. This would be enough to generate an additional 1,100MW of power for Ghana.

*The Oil and Gas Value Chain*

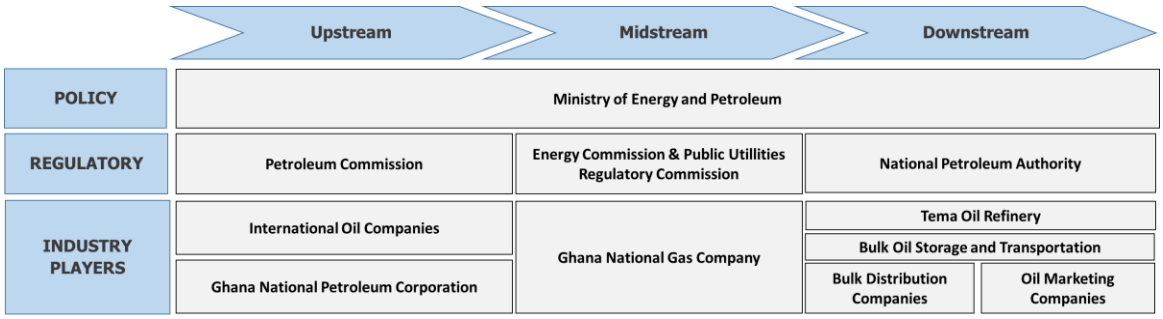
As the development of the local oil and gas sector in Ghana is recent, its local value chain is still developing and refocusing from a traditional import-oriented business. This section describes briefly the main actors along the value chain, and the local content regulation enforced since 2014. Appendix I includes a broader description of the sector value chain.

Main Actors along the Value Chain

The Ministry of Energy and Petroleum defines the sector policies and oversees the regulatory agents operating in the various segments of the value chain (figure 2.4). The Petroleum Commission (PC) oversees the upstream segment, including applications and compliance by the international oil companies (IOCs) and the Ghana National Petroleum Corporation (GNPC). The Energy Commission and the PURC oversee the actors in the midstream, including the Ghana National Gas Company (GNGC), in issues related to licensing and security of supply. The National Petroleum Authority regulates the downstream, including actors such as the Tema Oil Refinery (TOR), the Bulk Oil Storage and Transportation Company, bulk distribution companies (BDCs), and oil marketing companies (OMCs).

Six IOCs along with the GNCP own the licenses for the Jubilee, TEN, and Sankofa fields.[8] The GNCP is partner to all licensing agreements in the country as required by law. The GNGC is a subsidiary of the GNPC. The TOR, the Bulk Oil Storage and Transportation Company, 34 BDCs, and 96 OMCs serve the downstream segment. OMCs buy products from BDCs and sell them to the final consumers, either directly or through service stations and distributors. See figure 2.4.

**Figure 2.4: Main Actors along the Value Chain**




*Source:* GNPC 2016

Local Content Regulation

The Petroleum (Local Content and Local Participation) Regulation (LI 2204) was enacted in November 2013 and has been enforced since February 2014. Its main objective is to avoid what is known as the "resource curse" and to promote the utilization of local economic factors (people, goods, and services) by IOCs active in the upstream sector with the goals of instigating economic growth, reducing poverty, and contributing to the general prosperity of the citizens of Ghana.[9]

By adopting local content policies, countries encourage IOCs to become active players in the facilitation of links between the economy and the oil and gas sector. The local content policies are inspired by the Norwegian program Oil for Development.[10]

In Ghana, the local content regulation requires that, within a decade from the date of effectiveness of the license or the petroleum agreement, over 60 percent of goods and services be sourced from local companies and over 70 percent of technical and management staff be Ghanaians. IOCs submit a Local Content Plan (LCP) to the PC in which they outline the future procurement needs as well as the foreseen employment situation. The LCP includes a technology transfer subplan that outlines efforts aiming at transferring technology to Ghanaians and to indigenous companies. IOCs report annually to the PC on the progress toward the objectives of the LCP.

Operationally, the overall responsibility for monitoring of the implementation of the regulation lies with a Local Content Committee, operating under the direct authority of the PC, with responsibilities ranging from guideline preparation to recommendations to the PC. It is stressed here that the Local Content Committee does not itself accept or reject the LCPs. Its role is to make recommendations for accepting or rejecting the plans to the PC, which ultimately decides.

**Box 2.2: Definition of Local Content**

Local content in Ghana is defined as "the quantum or percentage of locally produced materials, personnel, financing, goods and services rendered in the petroleum industry value chain and which can be measured in monetary terms."

*Source:* Ghana Local Content Plan Template, http://www.petrocom.gov.gh/forms.html.

Worldwide, there are both good and bad experiences of local content regulation implementation. For example, local content regulation allowed Norway to build the capacity of local staff and suppliers of good and services.[11] Not only have these suppliers became competitive internationally, but the government used oil revenues to implement sound industrial policies in other sectors of the economy. The Norwegian local content regulation was later dismantled as requested by the country's commitments to the European Union. Angola also implemented local content regulation, but with negative consequences for its economy. It should be noted that depending on the country context and the format of the local content regulation, local cost could increase in the range of 15–20 percent for basic services, with extremes as high as 200–300 percent in some cases, compared to world market prices (Research 2017). Ghana can do much better given its stable democracy, active press and nongovernmental organization community, and stronger sector governance.

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## Notes

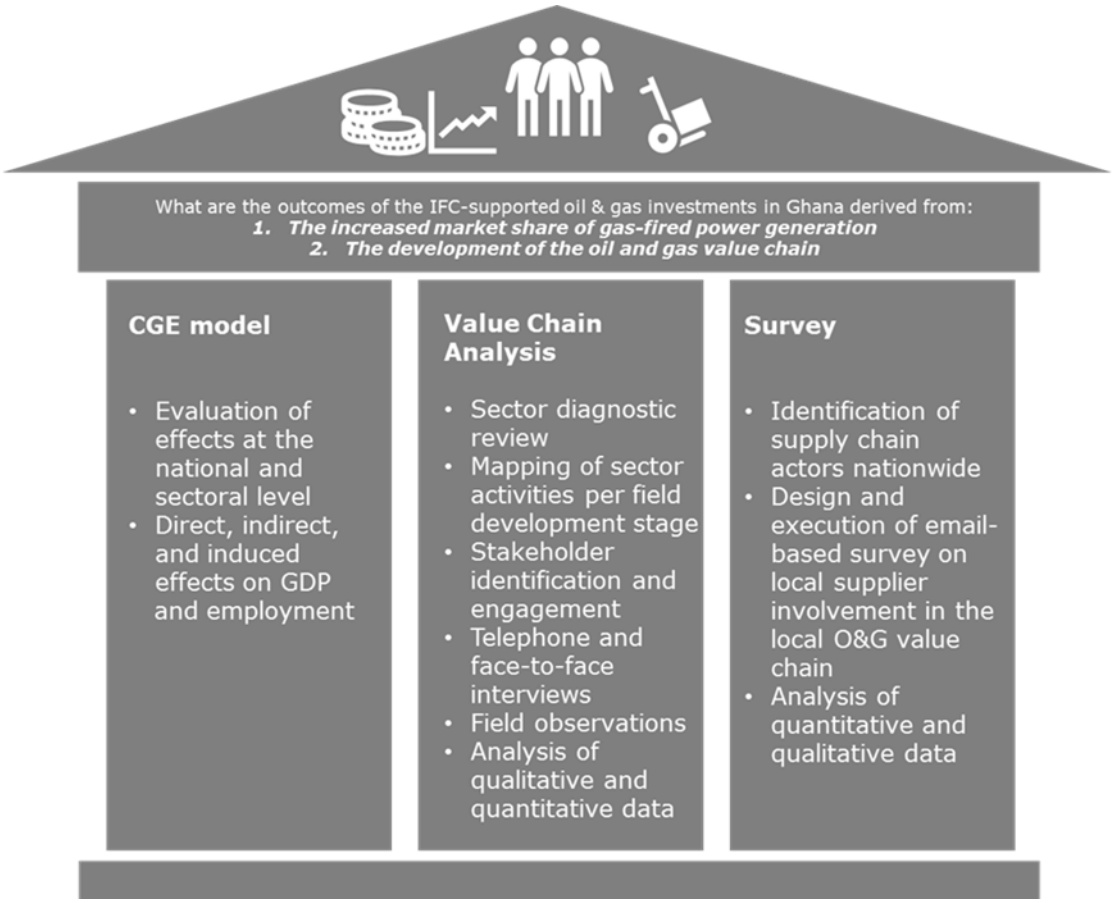
[1] Access to power is considered the biggest constraint by 50 percent of Ghanaian firms surveyed in IFC's Jobs Study of 2013; nearly four times higher than in the sample average of all African countries surveyed.
[2] Per IFC management information system, as of October 2017.
[3] The trade openness index is above 1, which reflects that the Ghanaian economy greatly depends on its exports and imports
[4] For example, most machinery is imported, including excavation machinery, electric generation sets, and gas turbines.
[5] The Akosombo Dam is Ghana's largest plant.
[6] World Bank data, "Electric Power Transmission, and Distribution Losses (% of output)," https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS.
[7] See Republic of Ghana, Ministry of Finance. 2016. *Ghana's Turnaround Story*. Accra: Ministry of Finance. http://www.mofep.gov.gh/sites/default/files/reports/economic/Ghana%20Investor%20Presentation-%20on%20the%20%27State%20of%20the%20Economy%27.pdf.
[8] The IOCs are Tullow Oil, Kosmos Energy, Anadarko, Petro SA, Eni, Vitol.
[9] "The resource curse is the failure of resource-rich countries to utilize their natural resources and translate them into wealth for their citizens." Natural Resource Governance Institute (NRGI) (2015). *The Resource Curse: The Political and Economic Challenges of Natural Resource Wealth*. [online] NRGI. Available at: https://resourcegovernance.org/sites/default/files/documents/nrgi_readers_compilation.pdf [Accessed 21 May 2018].
[10] Norwegian government institutions and experts offered strategic, technical, and legal support to Ghana's petroleum-related ministries and institutions. The aim was to contribute to building a strong Ghanaian capacity for resource management, environmental protection, and revenue management, including the legal and regulatory frameworks. Norway also shared relevant Norwegian experiences from civil society dialogue and mechanisms for coexistence among the petroleum sector, fisheries, and local communities.
[11] Norway also promotes the implementation of local content regulation through advisory services that they provide to resource-rich countries.

# 3. METHODOLOGY

## Introduction

The three building blocks (figure 3.1) of the methodological approach are the following: (i) application of the GEM-E3-G, a computable general equilibrium (CGE) model, which was used to quantify the effects on growth and jobs of potential scenarios for 2015–30; (ii) a value chain analysis, which gathered primary and secondary quantitative and qualitative data on the integration of local small and medium enterprises (SMEs) and Ghanaians in the upstream oil and gas value chain; and (iii) a company survey, which focused on all local companies interested in providing goods and services to the upstream oil and gas value chain.

**Figure 3.1: Building Blocks of the Study's Methodological Approach**




## CGE Model

The GEM-E3-G is used to estimate socioeconomic impacts of potential development scenarios for Ghana in 2015–30. A very detailed discussion of the model features is available in appendix C. The model quantifies economic and employment (direct, indirect, and induced[1]) impacts from the potential development scenarios categorized for this study.

The model was calibrated to the most recent available input-output table of Ghana (2015). It captured all the links among the different sectors and their exposure to international

competition, as it explicitly quantifies the share of imports and domestically produced goods in sectoral demand. They key modelling features and assumptions include the following:

- *Construction phase of the Jubilee, TEN, and Sankofa fields.* This stage requires services, materials, and equipment, some imported (for example, machinery) and others domestically produced.
- *Investments in the economy.* This category includes the field development, infrastructure, and other investments. They are broken into the specific products.
- *Government oil and gas revenues.* Public revenues from oil and gas discoveries consist of royalties and income taxes. The GEM-E3-G model can quantify the impacts of potential alternative scenarios of the use of these revenues by the government, including the upgrade of transport infrastructure (road and rail), telecommunications, and the power grid.
- *Transmission and distribution (T&D) losses.* The model can quantify the effects of the upgrade of the electricity T&D system. (T&D losses are currently high, at 28.3 percent.)
- *Power generation mix.* The current power generation mix is dominated by hydroelectric plants and thermoelectric plants fired with light crude oil and natural gas coming from Nigeria. The model can quantify the effects of increased locally produced natural gas.
- *Effect of electricity rates on production cost.* The model quantifies the impacts of changes in electricity rates on production costs and competitiveness of each sector, and how this affects domestic production and investments.
- *Ghana public budget.* The GEM-E3-G model includes a detailed financial and fiscal representation of the Ghanaian economy and can estimate the effects of further debt risk reduction (as translated into lower borrowing interest rates) on the domestic economy. The model can simulate the impacts of government decisions regarding spending of additional oil and gas revenues and fiscal policy formulation. The effect on public revenues is also estimated as the model captures both royalties and major types of taxation.

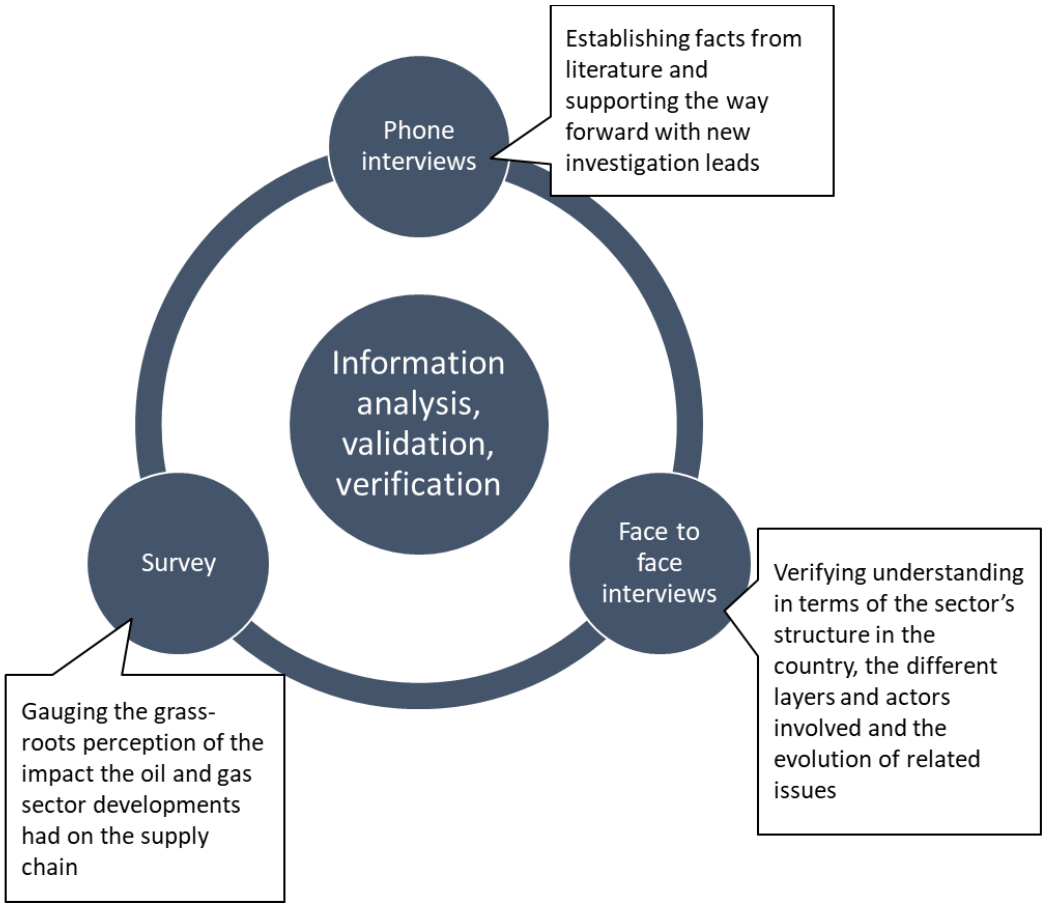
**Value Chain Analysis**

The value chain analysis focused on the degree of integration of the Ghanaian workforce and local suppliers in the upstream value chain. The research framework for the analysis utilized three methods for the collection of primary and secondary, quantitative and qualitative data. For the collection of primary data, the study triangulated the following approaches: qualitative in-depth interviews of main stakeholders, followed up by quantitative data collection from main stakeholders and a survey of local companies interested in supplying goods and services to the upstream segment (figure 3.2).

**Survey**

The e-mail-based survey's objective was to collect information from local companies interested in serving the oil and gas upstream value chain. The results are intended to complement the understanding of the investments' impact beyond the viewpoints of the main actors from the development side, the institutional side, and the nongovernmental organization/think tank side. The population of local companies was put together by combining sets of companies obtained from various sources, and the compiled list of suppliers was reviewed by Ghana's National Chamber of Commerce and the Takoradi Chamber of Commerce. A more detailed description of the survey method and procedure followed can be found in appendix K.

**Figure 3.2: Value Chain Analysis Investigation Tools for Collecting and Verifying Quantitative and Qualitative Information**




## Analysis

The quantitative and qualitative data gathered for the value chain analysis was processed according to the framework presented in figure 3.3. The indicators and metrics were chosen based on their relevance to assessing the integration of local resources in the upstream oil and gas value chain.

**Figure 3.3: Framework for the Analysis of the Local Contribution to the Upstream Oil and Gas Value Chain**

| Indicators / Measurement elements | Quantitative | Qualitative |
|---|---|---|
| Employment | Employment growth rate in industry | Specialties required by the sector, skills shortages |
| | Number of Ghanaians directly employed by IOCs over time | Educational/Training initiatives |
| | Employee statistics for IOCs | |
| | Number of Ghanaians employed in SMEs servicing the oil and gas sector (indirect employment) | |
| | Employment growth rate for Ghanaians - managerial positions, technical positions | |
| | Succession plan (expat positions take over by locals) | |
| | Percentage of local participation in the total number of specialties required by the sector | |
| | Training statistics: number of employees trained by IOCs and amounts spent on training programs | |

| Indicators / Measurement elements | Quantitative | Qualitative |
|---|---|---|
| Local Suppliers | Number of local suppliers to the oil and gas sector over time | Skills development |
| | Number of registered *vs.* number of active local suppliers | List of oil and gas sector clients served |
| | Local supplier ownership | Main activity type of local companies |
| | % by types of goods & services provided to the oil and gas sector | Specific goods/services local companies provide in the oil and gas sector |
| | Value of contracts with local suppliers | Company's view in terms of increasing/decreasing business as a proportion of goods/services provided to the oil and gas sector in the future |
| | % of the total value of goods & services provided by local suppliers that stays in Ghana | Gaps in the skills required by the company in order to serve the sector |
| | % of the investments made by the company in new equipment and/or technology can be attributed to the developments in the oil and gas sector | Initiatives for local supplier development |
| | | Critical constraints to increasing local sourcing |

## Study Limitations

- Ghana oil production is fully matched by the global demand until 2030.
- The alternative scenarios ignored a potential (though unlikely) adoption of more ambitious global climate change targets and energy policies aiming at a significant reduction of greenhouse gas emissions.[2]
- The analysis was made with the data provided by the Ghana's Statistical Service, IOCs, the PC, and the SMEs (via an e-mail-based survey). Although contact was made with a considerable cross-section of stakeholders, and evidence was obtained from all major actors in the sector, this is not necessarily reflected in completeness of the quantitative datasets collected.
- The impact of the oil revenues on the Ghanaian cedi and the uncertainty of the political economy has not been quantified by the model, which assumes a fixed exchange rate.[3]
- The study did not envision an interview-based SMEs survey. The information collected through an e-mail-based survey from a sample of the total SME population is not necessarily fully representative of the population.

## Notes

[1] *Direct impacts* refer to employment and economic activity resulting from the construction and operation of oil and gas fields. *Indirect impacts* are associated with the suppliers of equipment and materials used to build the oil and gas platforms and with the services and materials used to maintain the operation of oil and gas fields. Indirect impacts also include forward linkage effects (but not price effects, which are included in induced impacts). *Induced impacts* are associated with the price and income effects of the development of oil and gas fields in the economy, usually meant to be a result of the new equilibrium reached by the economy after having developed the fields. Induced impacts also include the effects of increased household income and spending of additional government revenues from oil and gas (and the potential economic benefits from changed electricity prices).

[2] For example, if this were the case, fossil fuels could be taxed, their demand reduced, and some of them could become stranded assets.

[3] Some oil- and gas-rich countries tend to adopt poor monetary policies that eventually lead to an overvaluation of their currency, thus undermining the competitiveness of their economy.

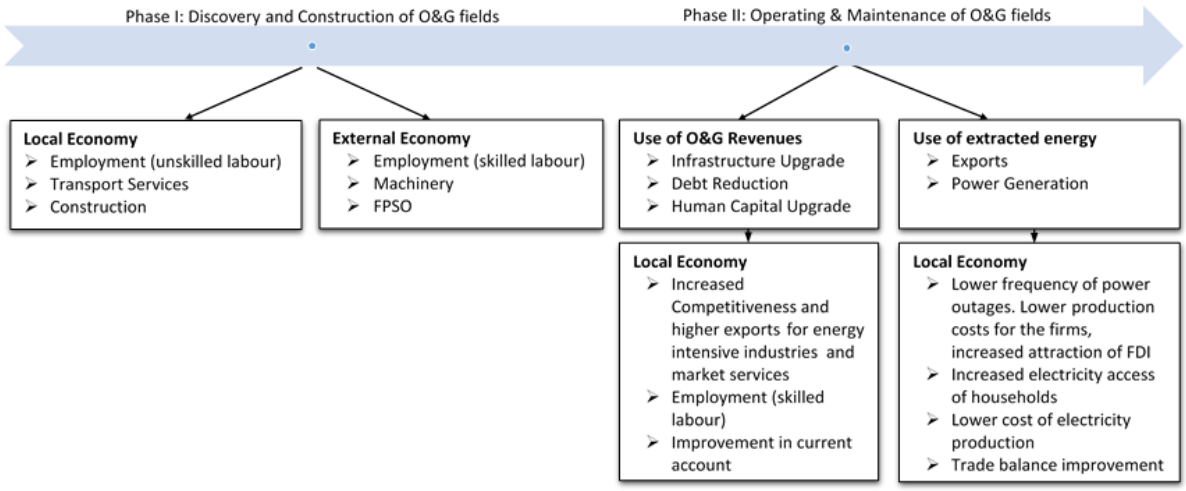
# 4. ANALYSIS AND FINDINGS

## Introduction

This chapter discusses the implications of potential and likely growth scenarios for Ghana linked to potential policy choices implemented by the government moving forward. These scenarios were designed and quantified using the GEM-E3-G model, which captures all different transmission channels through which Ghana's economy is affected (figure 4.1)

The potential effects of the oil and gas investments were estimated not only in a static context, during the period when the investments were made, but were projected until 2030. These effects depend on assumptions made on a multitude of factors, including economic and energy system structure, population and labor force, disposable household income, and oil and gas prices. Consequently, the GEM-E3-G model projections rely in turn on key assumptions in terms of technologies, energy-system structure, energy efficiency, demographics, and growth policies. Projections are categorized and specified in the form of growth scenarios.

**Figure 4.1: Transmission Channels for the Oil and Gas Sector**




*Source:* E3M elaboration.

*Note:* FDI = foreign direct investment; FPSO = floating production storage and offloading.

## Potential Growth Scenarios

The Full Scenario assumes that the three oil and gas fields are discovered and become fully operational. The study breaks down the Full Scenario into the following three stages: stage 1, the construction phase of the oil and gas fields; stage 2, the upgrade of the energy system; and stage 3, the investment in infrastructure financed with government oil and gas revenues. The Full Scenario includes the combined effect of stages 1–3 together (including productivity improvements induced by the infrastructure investments)

The study also compares the estimates from stages 1–3 and the Full Scenario with a Reference Scenario. The Reference Scenario hypothesizes a situation for Ghana in which no oil and gas fields were discovered, and therefore energy needs are met through imports of electricity and of natural gas from Nigeria through the West African Gas Pipeline (WAGP). However, as the transmission capacity of the WAGP is expected to be insufficient to meet the natural gas demand after 2020, the Reference Scenario also assumes the addition to the system of a small liquefied natural gas regasification terminal. Additionally, in the Reference Scenario, Ghana cannot export oil, and the country continues to use power generators fired with liquid fuels (light crude oil and diesel).

Important inputs to the model are the dates of the discovery of the field, the construction period, and associated investments (table 4.1).

**Table 4.1: Discovery, Construction Period, and Investments in the Jubilee, TEN, and Sankofa Fields**

| Field | Discovery | Construction period | Investment (US$ billion) |
|---|---|---|---|
| **Jubilee** | 2007 | 2008–2010 | 3.2 |
| **TEN** | 2009 | 2011–2016 | 4.9 |
| **Sankofa** | 2009 | 2011–2017 | 7.9 |

*Source:* E3M estimations based on the Tullow report for Jubilee (2017a) and TEN projects (2016) and the IBRD report for the Sankofa field (World Bank 2015).

The Full Scenario also assumes that the crude oil produced in the three fields is mostly exported, and that a small share is used for power generation and the Tema Oil Refinery (TOR) (table 4.2).

**Table 4.2: Projected Uses of Locally Produced Oil (1,000 barrels of oil per day)**

| Uses of oil | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Exports** | 0 | 11 | 29 | 39 | 59 | 104 | 168 | 118 |
| **Local refinery** | 20 | 22 | 11 | 10 | 4 | 2 | 2 | 3 |
| **Power generation** | 5 | 2 | 6 | 8 | 6 | 5 | 5 | 5 |

*Source:* E3M estimations based on projections by Republic of Ghana, Ministry of Finance. 2016. *Ghana's Turnaround Story*. Accra: Ministry of Finance; International Futures database, http://www.ifs.du.edu/ifs/frm_GraphicalDisplay.aspx; and calculations for oil use in power plants and in refineries.

Following the Ghana Gas Master Plan, the Full Scenario assumes that most of the locally produced gas is used by current and future thermoelectric power plants. It also assumes that a small share is dedicated to industrial consumption and none to residential consumption, because the latter is served with liquefied petroleum gas (LPG), produced by the Ghana National Gas Company.

**Table 4.3: Projected Uses and Imports of Natural Gas (million cubic feet per day)**

| Uses of gas | 2015 | 2020 | 2030 |
|---|---|---|---|
| **Power generation** | 112 | 230 | 380 |
| **Industrial consumption** | 0 | 22 | 72 |
| **Own use** | 3.4 | 7.6 | 13.6 |
| **Imports** | 74.8 | 0.0 | 168.3 |

*Source:* E3M estimations based on Ghana's Gas Master Plan projections for Ghana's fossil fuel production profile and gas use in industrial sectors and own calculations for gas use in power plants
*Note: Own use* refers to gas used in energy industries mainly for oil and gas production. Based on IEA data, the global share of gas own use in total gas production stood at about 9% in 2015, while for Nigeria the share is 8%, which was also used for Ghana.

The Full Scenario also assumes that electricity consumption grows in all sectors and the electrification of households increases as the gas production suffices to increase power generation capacity. According to the estimates of the Gas Master Plan, in the short term, gas production increases slowly to closely follow the growth of the demand from the existing generation capacity. However, as new gas transportation and power generation capacity is built

(table 4.4), local gas production increases to reach 305 million cubic feet per day in 2022, and gas imports are no longer needed by 2020. Although local gas production is expected to decline to 297 million cubic feet per day in 2030 because of declining reserves in the Jubilee field, gas demand continues to increase until 2030 to meet power generation demand. Consequently, gas imports are expected to kick in after 2025, though at a lower level than in the Reference Scenario.

**Table 4.4: Projected Gas-fired Generation Capacity MW)**

| Scenarios | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|---|
| **Reference** | 1,019 | 1,960 | 1,960 | 1,960 | 1,960 | 2,308 | 2,308 | 3,245 |
| **Base** | 1,019 | 1,960 | 1,960 | 2,308 | 2,308 | 2,833 | 3,856 | 4,580 |

*Source:* E3M estimations based on the Gas Master Plan projections.

Finally, the Full Scenario assumes that government oil and gas revenues are used to upgrade transport, telecommunication, and energy infrastructure (i.e. power generation, transmission and distribution) (table 4.5).

**Table 4.5: Projected Government Oil and Gas Revenues and Infrastructure Uses (US$ million)**

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Government oil and gas revenues** | **400** | **1365** | **1615** | **1842** |
| **Roads** | 132 | 449 | 531 | 606 |
| **Rail** | 78 | 267 | 316 | 361 |
| **Telecommunication** | 56 | 189 | 224 | 255 |
| **Power generation, transmission, and distribution** | 108 | 367 | 434 | 496 |
| **Gas transportation** | 27 | 92 | 109 | 124 |

*Source:* E3M estimations based on Ghana's fossil fuel production profile (largely derived from Gas Master Plan); global oil and gas prices (derived from IEA 2016); and the government of Ghana's "Sowing the Seeds for Growth and Jobs: 2017 Ghana Budget Highlights."

*Model Estimates*

The impact of the oil and gas fields on the economy and employment of Ghana depends on a multitude of factors. To identify the importance of each factor and its impact, the model-based assessment has been split in stages, as noted earlier. Each stage focuses on the implementation and evaluation of specific actions.

- Stage 1: Construction phase (development of oil and gas fields)
- Stage 2: Upgrading the energy system (gas replaces liquid fuels in power generation, increased electricity access of households)
- Stage 3: Investments to upgrade infrastructure

It should be noted that the decomposition of the scenarios in three stages is done to identify the importance of each factor separately. If only the all-inclusive scenario was presented, the net impact on gross domestic product (GDP) and employment would mask the contribution of each element. The scenarios examined and the rationale associated with each is presented in table 4.6 and in the following sections.

**Table 4.6 The Full Scenario with Stages 1–3 and the Reference Scenario.**

| Scenario | Description | Rationale |
|---|---|---|
| **Reference** | Oil and gas is not discovered in Ghana, and the growing energy needs are covered with imported natural gas and electricity. | This scenario is the "counterfactual," chosen to be compared with the other scenarios. |
| **Stage 1** | Includes the initial investments required to construct the Jubilee, TEN, and Sankofa fields. | Focuses on the estimated effects from the construction of the fields. |
| **Stage 2** | Adds to Stage 1 the effect of using the locally produced natural gas to produce electricity (replacing liquid fuels). | Estimates the effects on the economy from replacing liquid fuels with natural gas and from increased electricity access of households. |
| **Stage 3** | Adds to Stage 2 the effects of the government using the oil and gas revenues to build additional transportation, telecommunication, and power infrastructure capacity. | Focuses on the impact of using the public revenues from oil and gas to upgrade infrastructure. |
| **Full scenario** | It combines fully the effects of Stages 1, 2, and 3, including the productivity improvements induced by the infrastructure upgrade. | Estimates full potential effects on the economy of the three oil and gas fields. |

*Stage 1*

Stage 1 estimates the effect in the economy of the construction phase of Jubilee, TEN, and Sankofa (table 4.7); no effects of the government oil and gas revenues are considered. Total investment required to construct the three fields is approximately US$16 billion. It includes approximately US$7.2 billion in equipment—for example, for floating production storage and offloading (FPSO) vessels, flowlines, subsea trees, and manifolds); US$7.6 billion in well drilling; and US$1.1 billion in auxiliary services. Although these investments represented approximately 20 percent of the country's GDP in 2015, roughly 93 percent of them were sourced from overseas, reducing significantly their potential effect on the local economy.[1]

**Table 4.7: Investment in Jubilee, TEN, and Sankofa (US$ billion)**

| Field | Equipment | Well drilling | Auxiliary services | Total |
|---|---|---|---|---|
| **Jubilee** | 1.43 | 1.50 | 0.22 | 3.15 |
| **TEN** | 2.22 | 2.33 | 0.34 | 4.9 |
| **Sankofa** | 3.59 | 3.76 | 0.55 | 7.9 |
| **Total** | **7.24** | **7.60** | **1.11** | **15.95** |

*Source:* Study estimates based on public information made available by the companies involved (for example, Tullow 2016).

According to the GEM-G3-G model estimates, the effect of Stage 1 is a marginal 1.1 percent increase in GDP in 2010–17 over the GDP growth of the Reference Scenario in the same period[2]. The model also shows that this marginal GDP increase is mainly driven by investment, and secondarily by household consumption (table 4.8).

The effect on GDP is estimated by the model at US$5 billion, much lower than the total investment in the three fields. This is because a significant part of these investments benefits other economies (for example, Singapore, which fabricated the FPSO). Consequently, imports during the construction period increase by 3.7 percent as compared to the Reference Scenario.

The construction of the fields leads to an additional demand of domestically produced goods and services. This additional demand induces a limited increase in employment, which in turn leads

to an increase in wages and production costs. Higher wages would lead to increased household disposable income and to higher production costs that drive a limited decline in Ghanaian exports (relative to the Reference Scenario).

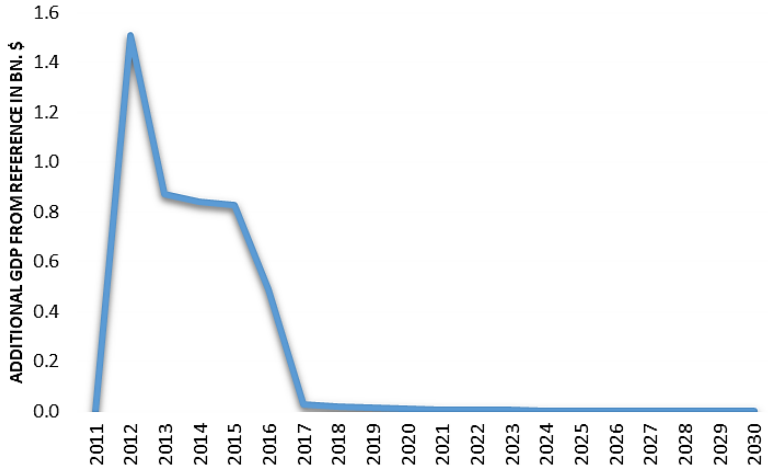
**Table 4.8: Stage 1 Marginal GDP Increase over the Reference Scenario**

| GDP and components | 2011–17 | 2018–30 |
|---|---|---|
| **GDP** | 1.1% | 0.01% |
| **Investment** | 7.7% | 0.01% |
| **Household consumption** | 0.8% | ~0% |
| **Exports** | -0.8% | ~0% |
| **Imports** | 3.7% | ~0% |

*Source:* GEM-E3-G.

The estimated effect of Stage 1 on the economy is mainly limited to the period from 2011 to 2017. Thereafter, there is no noticeable effect, as Stage 1 scenario assumes no other type of investments (figure 4.2).

**Figure 4.2: GDP Gains from the Construction of the Oil and Gas Fields**



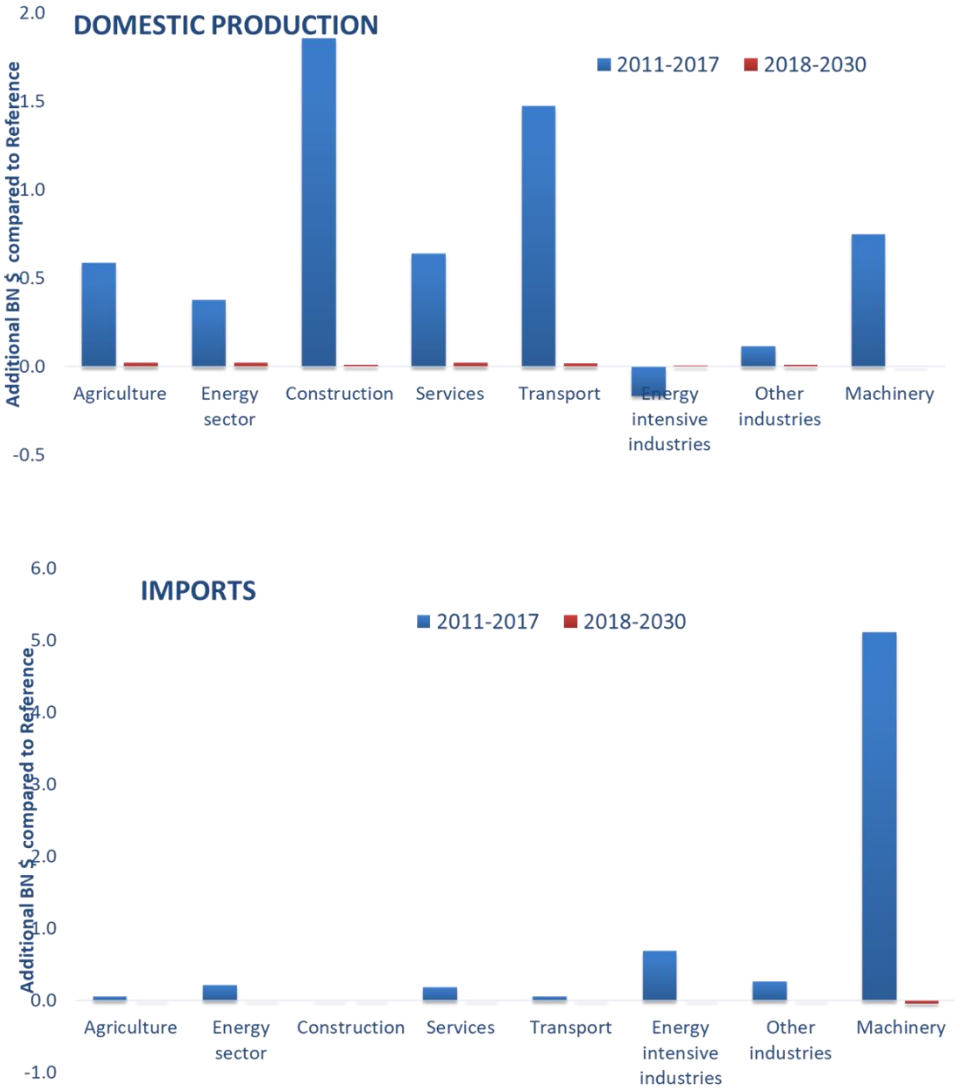

The model estimates in Stage 1 the addition of 3000 indirect and induced jobs[3] limited to the period 2011–2017 (table 4.9). These jobs were estimated to be mainly unskilled labor added in the transportation (62.1 percent) and the construction (33.9 percent) sectors, with a small number of job opportunities provided to local engineers.

**Table 4.9: Sectoral Share of Jobs Added in Stage 1**

| Sectors | Share in jobs created |
|---|---|
| Transportation | 62.1% |
| Construction | 33.9% |
| Engineering | 2.1% |
| Energy | 1.5% |
| Services | 0.5% |
| Agriculture | 0.3% |

For Stage 1, the model estimated larger GDP effects in the external economy than in the domestic economy (compared to the Reference Scenario) and a different sectoral distribution between these two economies (figure 4.3). Imports of machinery dominate in the external economy (US$5.1 billion), as most of the specialized equipment is produced overseas. In the domestic economy, the estimated effects are the largest in the construction (US$1.9 billion), transport (US$1.4 billion), and services (US$0.9 billion) sectors. The estimated positive effect on agriculture is driven by the increase in household income and consumption; meanwhile, the negative effect in energy-intensive industries is driven by increased production costs (due to higher wages) and reduced exports.

**Figure 4.3: Stage 1: Estimated Sectoral GDP Effects, Domestic versus External Economies, Compared to Reference Scenario (US$ billion)**

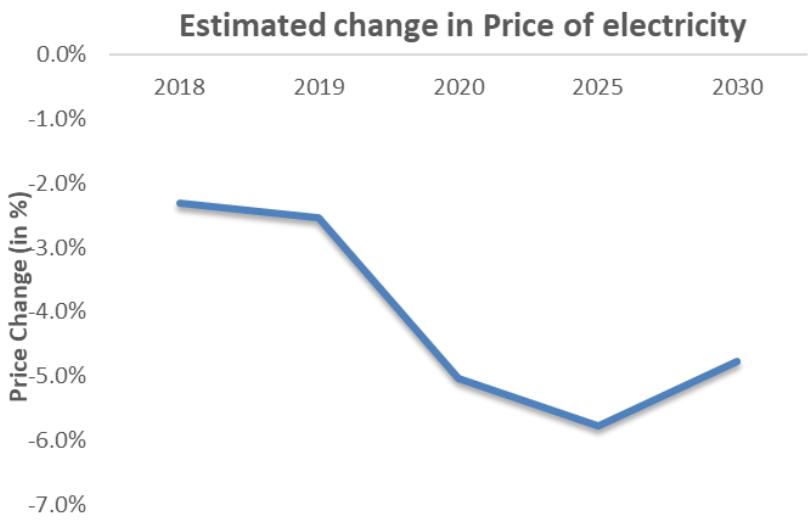



*Stage 2*

Stage 2 estimates the effect on the economy of the use of the locally produced gas to replace liquid fuels in power generation and industrial consumption (17 percent of electricity was generated with liquid fuels in 2017).[4] No effects of the government oil and gas revenues are considered (they are treated as government savings). The effect of Stage 2 on the economy is realized through increased direct employment and gas penetration in the energy system. As it was also assumed in Stage 1, households are expected to cook with LPG (instead of biomass).

Compared to the Reference Scenario, in Stage 2 the model estimates a reduced dependency on oil imports[5] and lower electricity rates[6] (figure 4.4). This also leads to a reduction in imports of power generators for individual use, because firms switch from self-generated electricity to buying electricity from the power grid.[7] Lower energy costs in turn improve firms' competitiveness, leading to increased production, exports, and household income. The increased household income leads to increased household consumption that is largely met by imports. The model also estimates the effects of the construction of additional gas-fired power generation on equipment (largely imported), construction (partly domestic), and other services.

**Figure 4.4: Estimated Change in Electricity Prices in Stage 2 from Reference Scenario (% change)**



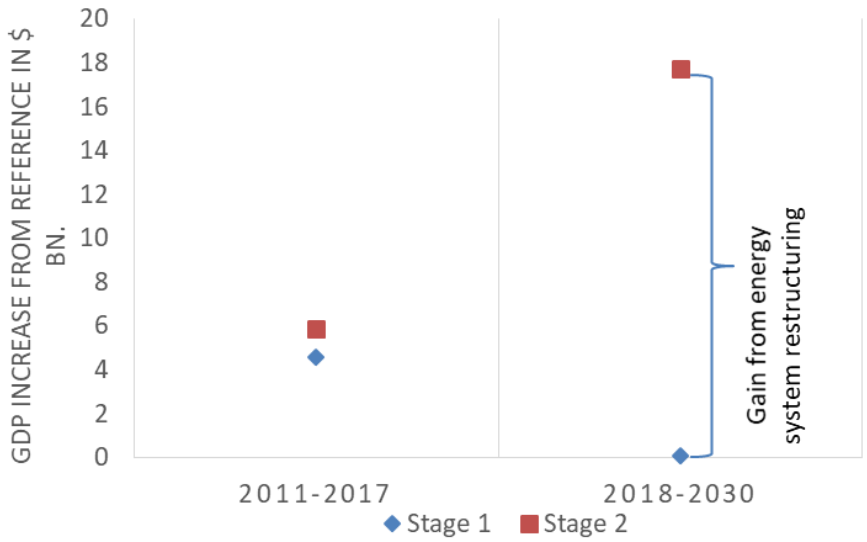

The GEM-E3-G model estimated short-term (2011–17) and long-term (2018–30) positive effects on GDP in Stage 2 (table 4.10). The short-term estimated effects are similar to the ones described in Stage 1. The long-term estimated effects include a GDP growth of 1.3 percent as consequence of a growth of 2.7 percent in exports, and 0.9 percent in investment, household consumption, and imports. As explained, they are a consequence of an increased electricity supply to households, substitution of self-generation with electricity purchases from the grid, and reduction in electricity cost.

**Table 4.10: Stage 2 Estimated GDP Growth (and Components) Compared with Reference (% change)**

| GDP and components | 2011–17 | 2018–30 |
|---|---|---|
| **GDP** | 1.4% | 1.3% |
| **Investment** | 7.9% | 0.9% |
| **Household consumption** | 1.0% | 0.9% |
| **Exports** | -0.2% | 2.7% |
| **Imports** | 3.8% | 0.9% |

Compared with Stage 1, the model estimates in Stage 2 that the additional gas penetration in power generation has the potential to deliver more permanent positive effects on the Ghanaian economy (figure 4.5). This is manifested in a significant GDP growth in 2018–30 above and beyond the GDP growth in the Reference Scenario.

**Figure 4.5: Stage 2 GDP Increase Compared with Stage 1 and Reference Scenario**




*Stage 3*

Stage 3 estimates the effect on the economy of the use of the government oil and gas revenues to improve the country's infrastructure (relative to the Reference Scenario). In this stage, the government implements policies that aim to improvement the road, rail, telecommunication, and energy infrastructure. The expected effect of these policies is higher demand in sectors that service the construction industry, as well as an increase in average total factor productivity. Although the construction demand effect is considered in Stage 3, the total factor productivity effect is considered only in the Full Scenario.

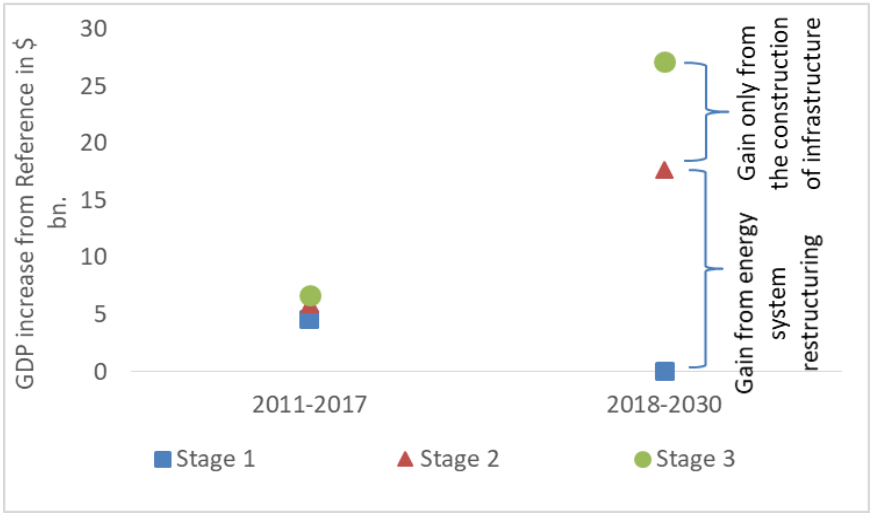
The GEM-E3-G model estimated short-term (2011–17) and long-term (2018–30) positive effects on GDP in Stage 3 (table 4.11). The short-term estimated effects are like the ones described individually in Stages 1 and 2. The long-term estimated effects include a GDP growth of 2.0 percent as a consequence of 2.4 percent growth in exports, 1.9 percent in investment, 1.8 percent in imports, and 1.3 percent in household consumption. As already explained, they are induced by an estimated decrease in electricity losses (about 19–25 percent in the Reference Scenario) as well as the additional construction demand and generation capacity.

**Table 4.11: Stage 3 Estimated GDP Growth (and Components) Compared to the Reference (% change)**

| GDP and components | 2011–17 | 2018–30 |
|---|---|---|
| **GDP** | 1.6% | 2.0% |
| **Investment** | 8.2% | 1.9% |
| **Household consumption** | 0.8% | 1.3% |
| **Exports** | -0.3% | 2.4% |
| **Imports** | 4.0% | 1.8% |

Compared with Stage 2, the model estimates in Stage 3 that the additional infrastructure has the potential to deliver more permanent positive effects to the Ghanaian economy (figure 4.6). This is manifested in a significant GDP increase in 2018–30 (0.7 percent) above and beyond the GDP growth in Stage 2 and the Reference Scenario.

**Figure 4.6: Stage 3 GDP Increase Compared with Stage 1, Stage 2, and Reference Scenario**




## Full Scenario: Macroeconomic Implications of Discovering the Oil and Gas Fields in Ghana

The Full Scenario estimates the combined effect on the economy of Stages 1–3 and the increased productivity induced by the infrastructure upgrade (relative to the Reference Scenario). The GEM-E3-G model estimated short-term (2011–17) and long-term (2018–30) positive effects on GDP in the Full Scenario (table 4.12). The short-term estimated effects are like the ones described individually in Stages 1, 2, and 3.

The long-term (2018–30) estimated effects include a GDP growth of 5.1 percent as a consequence of a growth of 7.5 percent in exports, 3.9 percent in investment, 3.6 percent in household consumption, and 2.9 percent in imports. The model also estimated that 166,500 sustained jobs are added to the domestic economy in the long term. These jobs are mainly added in the agriculture, energy-intensive industries, construction, and market services sectors. Agriculture is mostly benefited through the increased income of the Ghanaian households.

Additionally, in the Full Scenario:

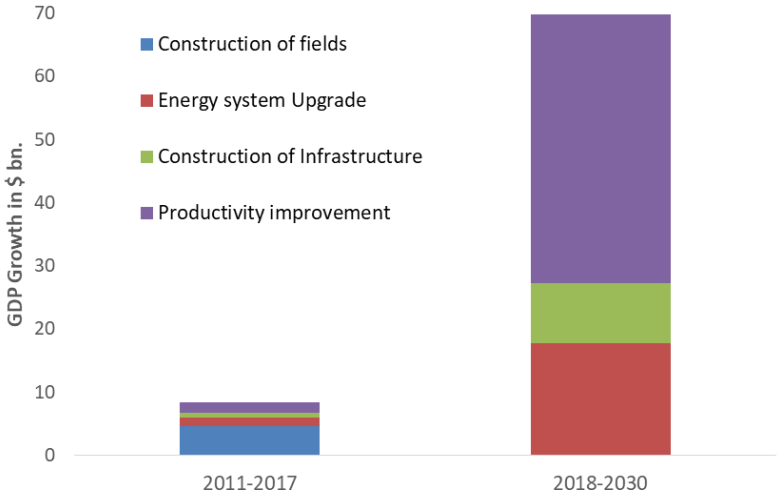
- The estimated annual rate of GDP growth is 6.4 percent (2015–30), while in the Reference Scenario is estimated at 6.07 percent.
- In absolute terms, GDP growth is estimated at approximately US$75 billion (2015–30).
- Oil and gas government cumulative revenues are estimated at US$21 billion (2015–30), meaning that GDP grew approximately 3.5 times the amount of the revenues over the same period.

**Table 4.12: Full Scenario Estimated GDP Growth (and Components) Compared with Reference Scenario (% change)**

| GDP and components | 2011–17 | 2018–30 |
|---|---|---|
| **GDP** | 2.0% | 5.1% |
| **Investment** | 8.5% | 3.9% |
| **Household consumption** | 1.1% | 3.6% |
| **Exports** | 0.2% | 7.5% |
| **Imports** | 4.1% | 2.9% |

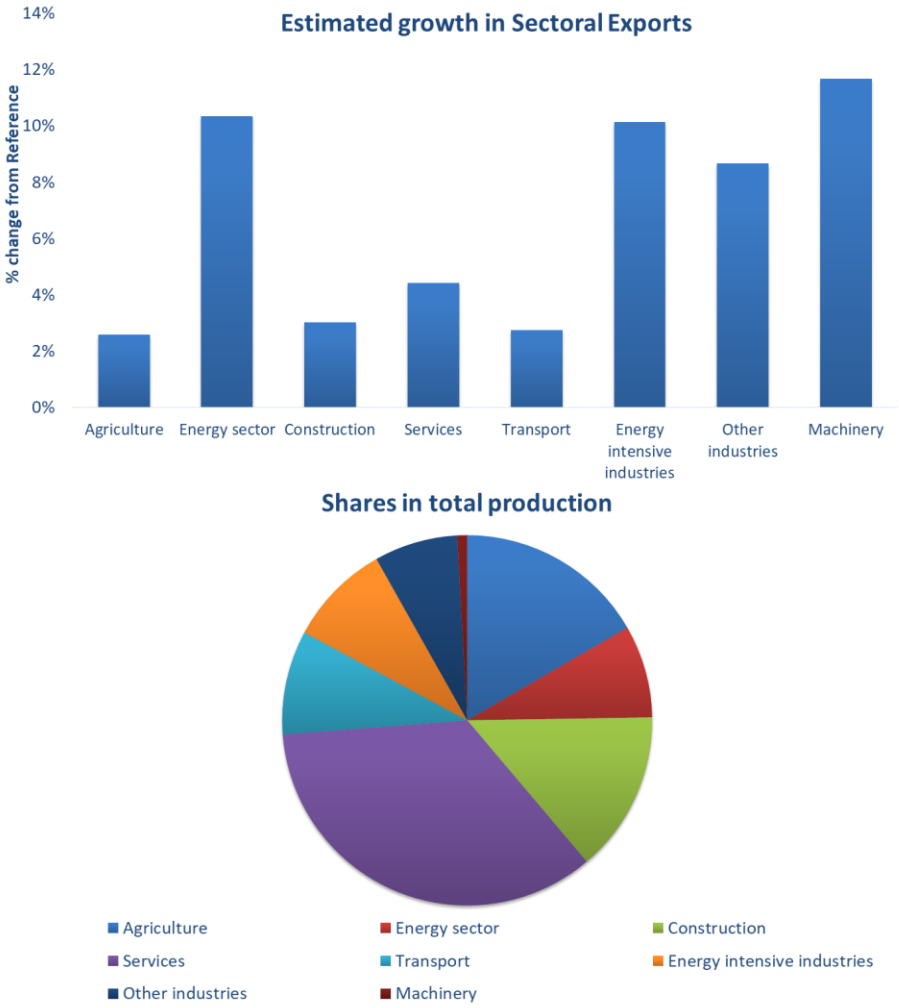
Compared to the Reference Scenario, the GEM-E3-G model estimated that in the Full Scenario the largest contributor to GDP growth (2018–30) is productivity improvement (US$43 billion), followed by the upgrade of the energy system (US$18 billion) and infrastructure construction[8] (US$10 billion) (figure 4.7). The expected effect of the implementation policies is fast and low-cost transportation, modern telecommunications, and more efficient energy grids (Appendix N).

**Figure 4.7: Full Scenario Factors Contributing to GDP Growth versus Reference Scenario in 2011–30**




As noted (table 4.12), in the Full Scenario, the largest component of the estimated GDP growth is exports, followed by investment. Compared to the Reference Scenario, the model estimated that the export sectors expected to grow the most are machinery (11 percent), energy-intensive industries (10 percent), and other industries (9 percent) (figure 4.8). Firms increase their exports as their competitiveness (measured as changes in relative prices) improves from the Reference Scenario. Both the productivity gains that the upgrade of infrastructure delivers and the lower energy costs that are driven by the locally produced gas lead to a reduction of production costs for Ghanaian firms. The sectors that benefit the most are those that highly depend on energy and at the same time are open to trade (nonmetallic minerals and metals).

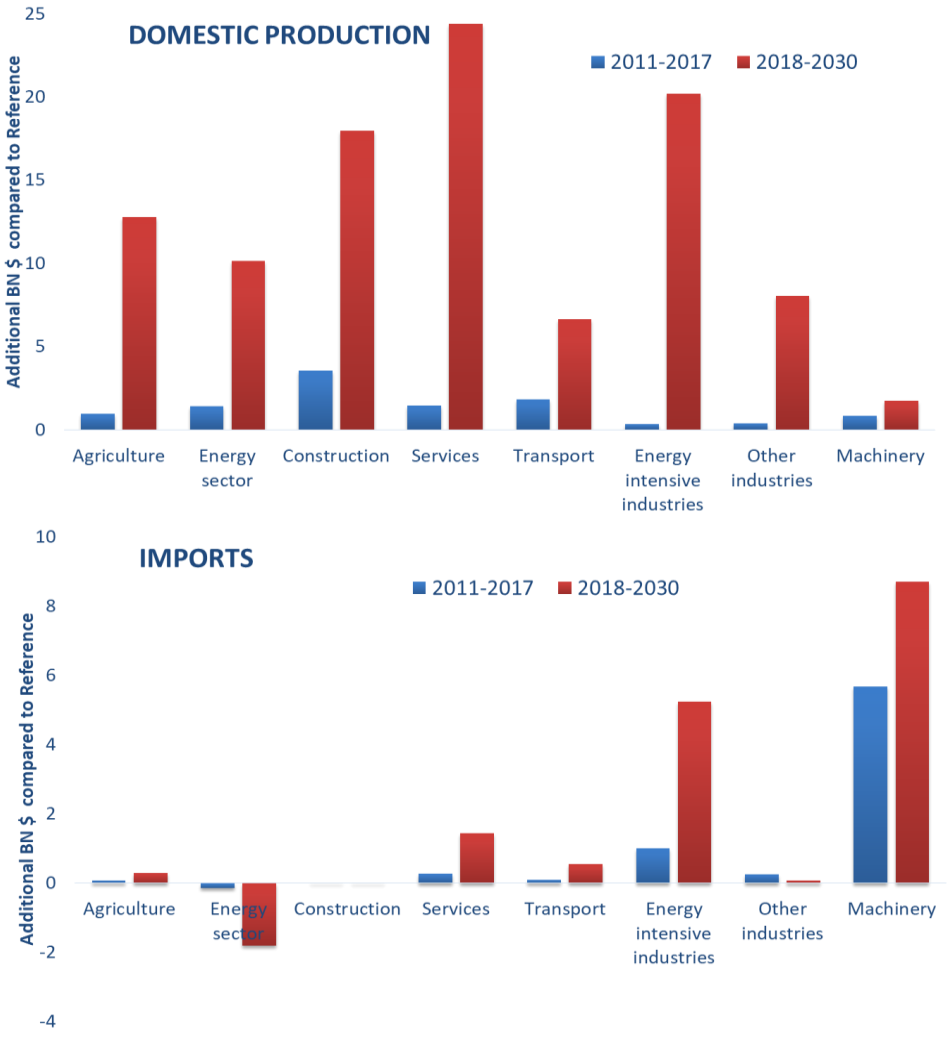
**Figure 4.8: Full Scenario Estimated Export Growth (Relative to Reference Scenario) and Sectoral Share of Domestic Production (2015–30)**




For the Full Scenario, the model estimated that the domestic economy of Ghana benefits to a larger extent than the external economy (figure 4.9). The expected increase in total factor productivity from infrastructure investment is therefore estimated to benefit the domestic economy widely.

In the domestic economy, the estimated effects are the largest in the services (US$26 billion); energy-intensive industries—for example, metals and minerals (US$21 billion); construction (US$21 billion); and the agriculture (US$14 billion). Imports of machinery dominate increase at US$14 billion, as most of the specialized equipment is produced overseas, followed by the energy-intensive industries (US$6 billion). These projections confirm the findings of a recent International Finance Corporation study (IFC 2016) on the complexity and fitness of the Ghanaian economy. This study identified nonmetallic minerals and metals as "competitive exports that are growing above the global average," and transport and business travel as the services with the largest export volume potential.

**Figure 4.9: Full Scenario Sectoral GDP Estimated Effects, Domestic versus External Economies Compared to Reference Scenario (US$ billion)**

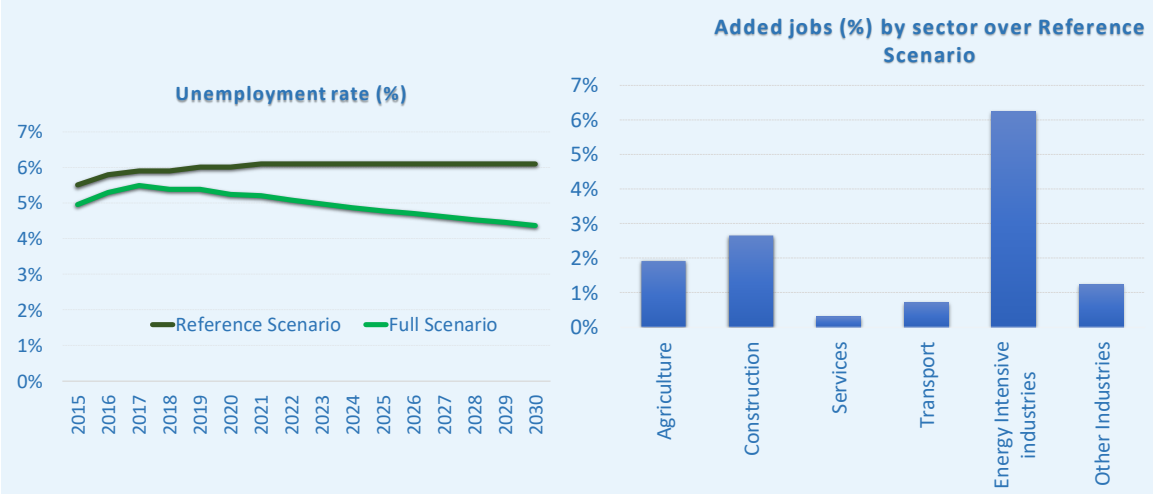



The model estimates a steady decrease in 2015–30 of the unemployment rate to a value close to the natural rate of unemployment. This is consequence of the investments in the oil and gas fields and the power sectors and the use of the oil revenues to the government. Regarding sectoral effects on employment, the growth in the construction and energy-intensive sectors are driven by the investments in infrastructure, whereas the growth changes in agriculture are driven by the increase of household income.

According to the GEM-E3-G model estimates for 2015–30, the multiplier effect of the development of the oil and gas sector would be much larger on GDP than on employment. This is because the model considers that the oil revenues would be used to upgrade infrastructure and help to improve labor productivity and the competitiveness of the economy leading to higher income. As productivity increases, income increases but fewer labor hours are needed per unit

of output. Further context in terms of the growth and employment multiplier effects and some country benchmarks is provided in detail in appendix D.

**Figure 4.10: Estimated Effects on Overall Unemployment Rate and on Labor Force by Sectors (2015–30)**




*Full Scenario Variants to the Use of Government Oil and Gas Revenues*

As the model results are highly dependent on the ultimate uses of oil and gas revenues by the government, the study also estimated five Variants of the Full Scenario where alternative uses of Oil and Gas revenues are considered. Each Variant represents a different assumption about government policies related to: boosting investment (general infrastructure, energy system, education), reducing debt, and increasing household consumption (table 4.13).

Variant 1

Description: The study assumes that the government revenues are dedicated to upgrading the infrastructure in general, while no new investments are made in the power grid.

Estimated outcome: (+) The annual GDP growth rate is estimated in 4.52 percent, which is 0.12 percentage points higher than the annual growth rate for the Full Scenario. This seems to hint that investment in general infrastructure may have a higher multiplier in the economy than the ones in the power grid. However, the model does not provide information on the sustainability of this type of policy. Compared with the Reference Scenario, this variant is also the only one that adds more FTE jobs (approximately 200,400), and they are mainly added in the agriculture sector (figure 4.10).

Variant 2

Description: The study assumption is that the government uses part of the revenues to invest in infrastructure and the balance to boost low income household consumption.[9] This type of policy would aim at reducing income inequality by subsidizing consumption to stimulate demand.[10]

Estimated outcome: (-) The annual GDP growth rate is estimated in 4.28 percent, which is 0.12 percentage points lower than the annual growth rate for the Full Scenario.[11] Although initially

consumption may stimulate domestic demand, in the long run this effect vanishes because there is no productivity increase.

Variant 3

Description: The study assumes that the government uses 50 percent of the revenues to invest in infrastructure and the balance to improve the debt profile of Ghana. Based on historical evidence, the study also assumes that a debt reduction to below 50 percent of GDP has no impact on the borrower interest-rate level and on the domestic economy. According to the most recent International Monetary Fund forecast (IMF 2017), the public debt of Ghana would decline below the benchmark of 56 percent by 2022 with a further reduction after 2022.

Estimated outcome: (-) The annual GDP growth rate is estimated at 4.24 percent, which is 0.16 percentage points lower than the annual growth rate for the Full Scenario. As the debt level of the Full Scenario is not unsustainable, this variant does lead to a slightly negative estimated effect.

Variant 4

Description: The study assumes that the government uses part of the revenues to invest in the country's human capital via increased expenditure in education. The revenues in this variant were allocated in the same proportion as in the national budget in 2017—that is, 76 percent to education, 16 percent to infrastructure, and 8 percent to the power grid.[12] The upgrade of human capital is expected to drive GDP growth through two main channels by (i) increasing average productivity of workers, independently of whether they eventually work in their field; and (ii) increasing skills availability for higher value added economic activities.[13]

Estimated outcome: (+, but in the longer term) The annual GDP growth rate over 2015–30 is estimated at 4.25 percent, which is 0.15 percentage points lower than the annual growth rate for the Full Scenario. Although investments in education per the literature lead to increased labor productivity across sectors, with an elasticity of 0.211 (Odior 2011), these effects are more noticeable with at least a one-generation lag, that is, 20–25 years (Lee and Mason 2010). Compared with the Reference Scenario, this variant is also the only one that adds more FTE jobs in the services sector (figure 4.11).

Variant 5

Description: The study assumes that electricity rates for consumers remain at the same level as in the Reference Scenario, that is, electricity rates in variant 5 would be higher than in the Full Scenario, and that the government uses this surplus to increase expenditures (boosting demand in the process). The Full Scenario had assumed that electricity prices fully reflected production costs; however, as it had also assumed that liquid fuels would be substituted with less expensive natural gas to fire the power plants, electricity rates would ultimately be lower in the Full Scenario than in the Reference Scenario.

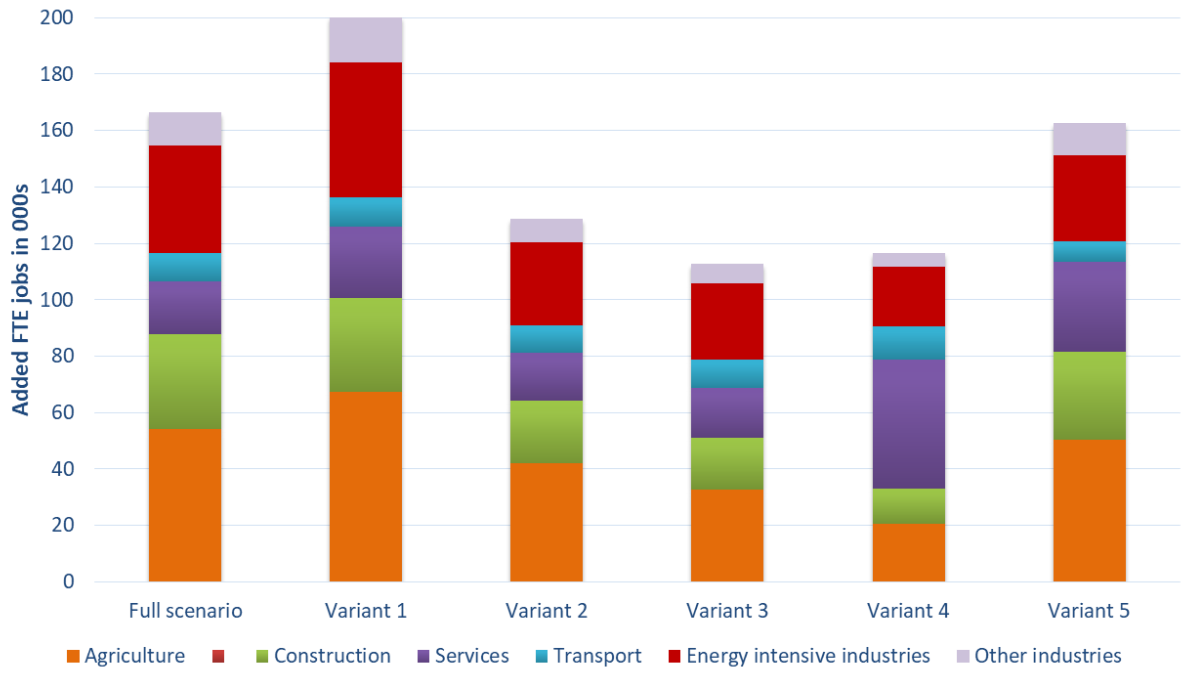
Estimated outcome: (-) The annual GDP growth rate is estimated at 4.38 percent, which is 0.02 percentage points lower than the annual growth rate for the Full Scenario. The effect seems to be slightly negative.

**Table 4.13: Full Scenario Variants to the Use of Government Oil and Gas Revenues 2015–30 (GDP growth rate, additional GDP, FTE jobs added, and proportion of workforce)**

| Scenarios and variants | GDP growth rate (annual) | Added GDP (cumulative US$ billion) | Added full-time equivalent (FTE) jobs[a] | Proportion of added FTE jobs to total workforce |
|---|---|---|---|---|
| **Reference Scenario** | 6.07% | n.a. | n.a. | n.a. |
| **Full Scenario** | 6.40% | 74 | 166,500 | 1.1% |
| **- Variant 1** | 6.52% | 93 | 200,400 | 1.3% |
| **- Variant 2** | 6.28% | 55 | 128,650 | 0.8% |
| **- Variant 3** | 6.24% | 48 | 112,600 | 0.7% |
| **- Variant 4** | 6.25% | 44 | 116,670 | 0.8% |
| **- Variant 5** | 6.38% | 72 | 162,500 | 1.1% |

[a] Jobs are estimated as FTE positions on average over 2015–30 (for example, if 2,000 work hours is equivalent to one FTE job, and total added work hour is 200,000 in 2015–30, then added FTE jobs is 7 (200,000 hours/15 years/2,000 hours).

**Figure 4.11: Full Scenario Variants to the Use of Government Oil and Gas Revenues, 2015–30 (FTE jobs added, by sector)**




*Full Scenario Sensitivities to Total Factor Productivity and Oil and Gas Price*

The study also quantified sensitivities to total factor productivity (TFP) and to the level of oil and gas prices (table 4.14). As the link between infrastructure investment and TFP is uncertain,

potential TFP upper and lower bounds were researched in the literature. The annual GDP growth rate estimated for the upper TFP bound is 4.55 percent (sensitivity 1), which as expected is higher than the annual growth rate for the Full Scenario (by 0.15 percentage points). Quantified with the lower TFP bound (sensitivity 2), the model estimated a lower annual GDP growth rate than the Reference Scenario (by 0.12 percentage points).

As the amount of oil and gas revenues depends on the level of the oil and gas prices, the study quantified six potential oil and gas price scenarios (sensitivities 3–8). They are based on the two projections of the World Energy Outlook 2016 (IEA 2016): the IEA New Policies Scenario[14] (sensitivity 7), and the IEA 450ppm[15] (sensitivity 8). Four additional sensitivities were quantified with oil and gas prices assumed to be +/- 20 percent (sensitivities 3–4) and +/- 50 percent (sensitivities 5–6), the ones used to quantify the Reference Scenario (figure 4.12).[16]

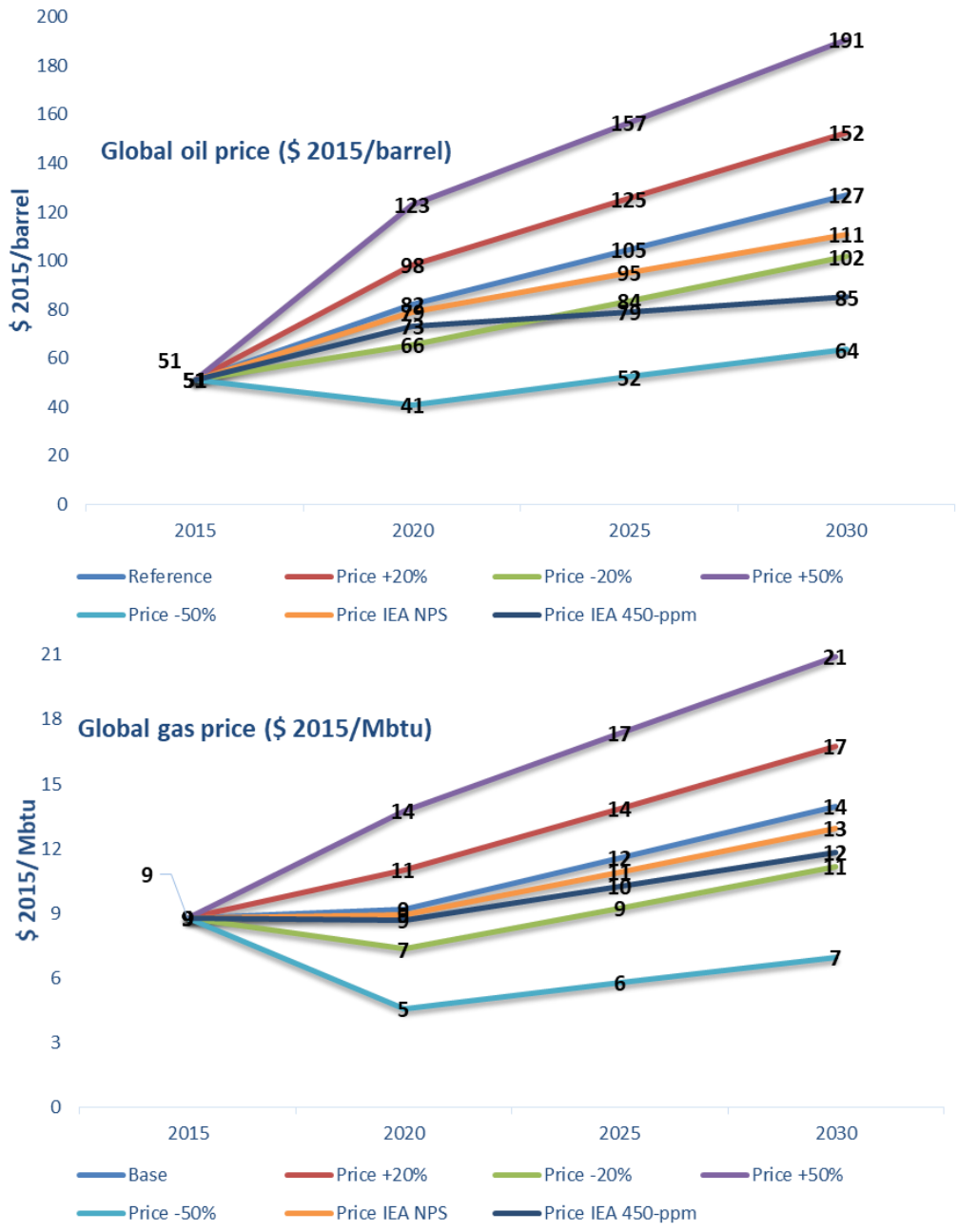
Not surprisingly, the estimated annual GDP growth rates for Sensitivities 3 and 5 are higher than the annual growth rate for the Full Scenario (by 0.08 and 0.13 percentage points, respectively). However, this relationship is not linear as higher oil and gas prices impact negatively the economy of countries that are not oil and gas producers, which reduces ultimately their demand for Ghanaian goods and services.

**Table 4.14: Full Scenario Sensitivities to Total Factor Productivity and Oil and Gas Price 2015–30 (GDP growth rate, additional GDP, FTE jobs added, and proportion of workforce)**

| Scenarios and sensitivities | GDP growth rate (Annual) | Added GDP (cumulative US$ billion) | Added full-time equivalent (FTE) jobs[a] | Proportion of added FTE jobs to total workforce |
|---|---|---|---|---|
| **Reference scenario** | 6.07% | | | |
| **Full scenario** | 6.40% | 74 | 166531 | 1.1% |
| **Sensitivity 1:** High total factor productivity | 6.55% | 96 | 205595 | 1.4% |
| **Sensitivity 2:** Low total factor productivity | 6.29% | 60 | 137286 | 0.9% |
| **Sensitivity 3:** Oil and gas price +20% Baseline | 6.48% | 86 | 176704 | 1.2% |
| **Sensitivity 4:** Oil and gas price -20% Baseline | 6.31% | 63 | 156447 | 1.0% |
| **Sensitivity 5:** Oil and gas price +50% Baseline | 6.53% | 94 | 175851 | 1.2% |
| **Sensitivity 6:** Oil and gas price -50% Baseline | 6.28% | 57 | 161801 | 1.1% |
| **Sensitivity 7:** Oil and gas price IEA new policies scenario | 6.32% | 65 | 154857 | 1.0% |
| **Sensitivity 8:** Oil and gas price IEA 450-ppm scenario | 6.30% | 62 | 156151 | 1.0% |

[a] Jobs are estimated as FTE positions on average over 2015–30 (for example, if 2,000 work hours is equivalent to one FTE job, and total added work hours is 200,000 in 2015–30, then added FTE jobs is 7 (200,000 hours/15 years/2,000 hours).

**Figure 4.12: Oil and Gas Price Projections, 2015–30**



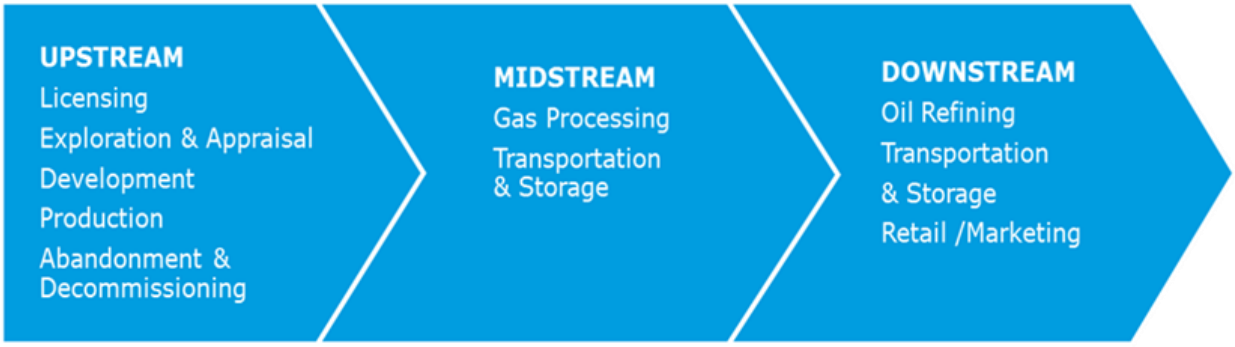

Note: Based on two main projections of the *World Energy Outlook 2016* (IEA 2016): the IEA New Policy Scenario (IEA NPS), and the IEA 450ppm. Four additional sensitivities were quantified, they are: Reference prices +/- 20%, and Baseline +/- 50%.

## Potential Effects on the Upstream Oil and Gas Value Chain

The oil and gas discovery created high expectations of a significant positive impact on the Ghanaian economy, local economic activity, and peoples' livelihoods. The oil and gas value chain comprises three segments: upstream, midstream, and downstream (figure 4.13).[17] This section makes an early assessment of the potential value chain development effects resulting from the Jubilee, TEN, and Sankofa fields development based on quantitative and qualitative primary and

secondary research on job creation and growth. As discussed earlier in the report, the sector is still in a nascent stage, as the first commercially exploitable field was discovered in 2007, first oil was extracted in 2010, and the local content law sanctioned in 2014. Consequently, the analysis seeks to establish and discuss, to the extent possible, effects before and after the introduction of the local content law.[18]

**Figure 4.13: Typical Offshore Oil and Gas Value Chain**




This section briefly discusses local content practices and regulation, and subsequently assesses employment and small and medium enterprise (SME) effects of the development of the oil and gas fields in the upstream and midstream as observed in the period 2007–16.

*Local Content Practices and Regulation*

Ghana engaged with international companies in the exploration, construction, and operation phases of Jubilee, TEN, and Sankofa. As explained before, these are relatively recent developments, as the first oil and gas discovery occurred in 2007 in the Jubilee field (which entered operation in 2010). The TEN field was discovered in 2009 and entered operation in 2016. The Sankofa field was discovered in 2011 and entered operation in 2017.

To promote local participation in the oil and gas upstream, the parliament passed two key pieces of legislation: (i) the Petroleum Commission Act established the Petroleum Commission for the regulation and management of the utilization of oil and gas resources, and (ii) the Petroleum (Local Content and Local Participation) Regulations (L.I 2204). Enforced since 2014, the Local Content and Local Participation Regulation (LCR) promotes maximization of value-addition and job creation through the use of local expertise, goods and services business, and financing in the petroleum industry value chain. Every local and foreign contractor, subcontractor, licensee, corporation, or other allied entity carrying out oil and gas activities has a responsibility to ensure local content forms a central plank of its operations (table 4.15). The legislation makes further provisions in the areas of education, skills transfer and development, technology transfer and research and development programs.

As the LCR was enforced starting in only 2014, most of the local content in the upstream until then was probably driven by market forces. Moreover, most international oil companies (IOCs) had experience working in other African countries with no local content requirements and were aware of the benefits of utilizing local resources in the construction and operation of oil and gas fields. For example, in Nigeria oil was discovered in 1956, production starting shortly after, but it was not until the early 2000s that the country actively sought to explore ways of ensuring successful implementation of a local content policy. The Ghana National Petroleum Corporation (GNPC) was mandated by the Ministry of Petroleum and Energy of Ghana in 2009 to create a database of local suppliers. IOCs would make regular contact with the GNPC to obtain details for the possible procurement of services by registered local companies, but it was up to the IOCs' and GNPC's own initiative to explore and communicate opportunities for local participation.

Consequently, the extent to which the LCR has influenced the inclusion of local economic factors in the upstream is still unclear and difficult to disentangle from the effects of other industrial policies and the political economy. Therefore, the study could not assess its effectiveness but discusses its potential implications where possible.

**Table 4.15: Local Content and Local Participation Minimum Standards (employment, procurement)**

| Item | Start | 5 years | 10 years |
|---|---|---|---|
| **1. Recruitment and training** | | | |
| **Management staff** | 30% | 50%–60% | 70%–80% |
| **Technical core staff** | 20% | 50%–60% | 70%–80% |
| **Other staff** | 80% | 90% | 100% |
| **2. Goods and services** | 10% | 50% | 60%–90% |

*Source:* Local Content and Local Participation Regulations (LI2204).

While local content requirements are typically seen quite negatively in the foreign direct investment literature, the creation of employment positions and of forward and backward links in the oil industry itself are an important policy objective. To achieve value retention and job creation objectives, countries are faced with the tradeoff between (indirectly) taxing oil companies through performance requirements and (directly) increasing taxation and using the funds to promote jobs elsewhere in the economy. The underlying assumption here is that these additional revenues would be collected and spent efficiently, which is certainly not a given. When public administration and investment management are weak, local content regulation can be an acceptable second best in sectors such as oil and gas, where investors are less sensitive to these requirements.

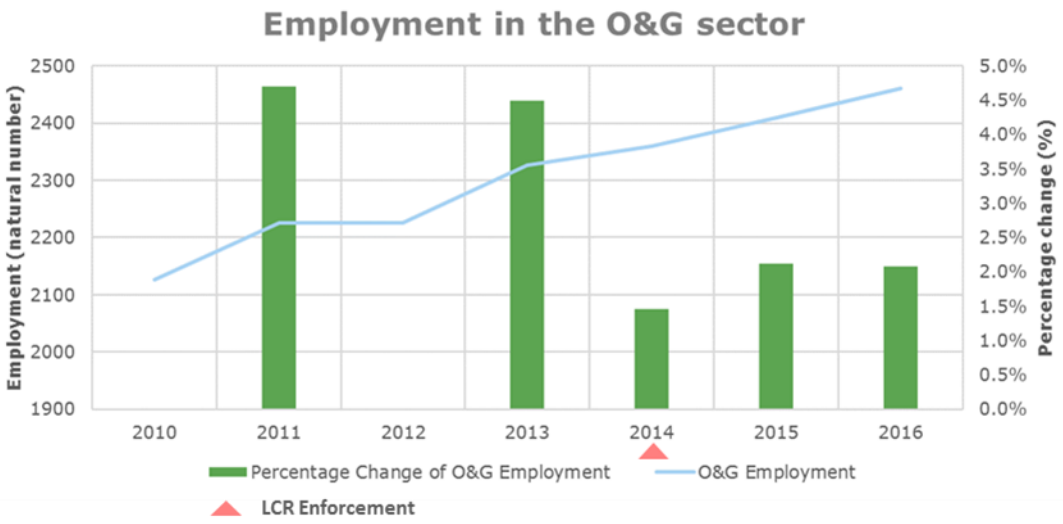
The revenues received by the government of Ghana from the oil and gas industry constitute a considerable amount of GDP annually, amounting to 1.5 percent of GDP (2016) on average for the 15-year period examined (2015–30).[19] It is noted that the total investment cost for developing the three fields is close to 20 percent of Ghana's 2016 GDP. However, this is a cost picked up by private investors and not the government. Given the size of the investment required and the fact that the vast majority of the investment is sourced from overseas, in theory an opportunity arises for local participation that could potentially benefit the economy significantly.

## Employment Effects

*Total Employment*

There are limited employment opportunities in the oil and gas sector available to Ghanaians. This is principally due to a combination of two factors. First, the sector is generally knowledge and technology intensive, rather than labor intensive (Darvas and Palmer 2014). Second, oil and gas production is a recent addition to the economy; therefore, education and vocational training programs have not been in place for sufficient time to produce the level of skills required by the sector. Indirect employment is also not as pronounced as in other extractive industries, for example mining (World Bank 2011). In 2016, employment in the oil and gas sector represented 0.02 percent of the total workforce;[20] meanwhile, mining represented 1.6 percent. Therefore, although oil- and gas-related employment did increase over the years (figure 4.14), its contribution to the overall employment levels has probably not met the ex-ante expectations.

**Figure 4.14: Employment in the Oil and Gas Sector**




*Source:* Data provided by the Statistical Service of Ghana.

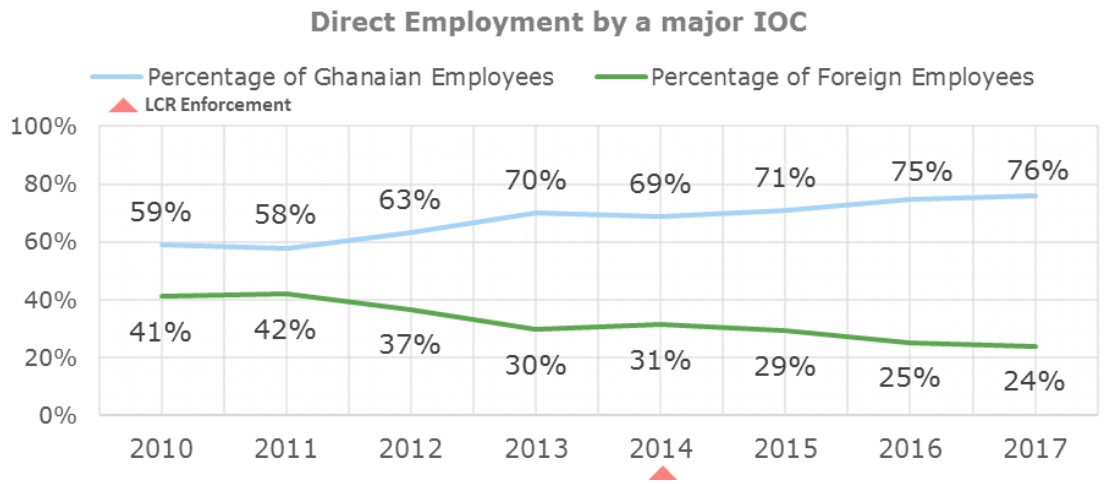
Employment levels fluctuated with the various stages of the development of the Jubilee, TEN, and Sankofa fields. The increase in 2011 can be attributed to the Jubilee field entering production. Employment increases again rose significantly in 2013, presumably because of the approval of the Plan of Development of the TEN field (beginning of construction phase) and of the *Jubilee Phase 1A Development Plan* in 2012. It continues to grow steadily (but at a slower pace) owing to the construction phase of Sankofa and the coming into force of the LCR in 2014. This slower pace is linked to the fact that, by this time, both Jubilee and TEN were in production, therefore requiring fewer personnel.

The type of employment also varies with the development stages of the three fields. For example, IOCs interviewed mentioned that over 60 percent of the workforce (direct and subcontractors) were expatriate during the exploration phase, but that the construction and production phases require fewer expatriates.

*Direct Employment Effects*

For this study, direct employment is defined as jobs created by the major oil and gas companies in the upstream (for example, Tullow and Eni, see appendix I). These companies employ both local and foreign staff in proportions that change with the stage of development of their fields. The exploration phase is an expatriate-driven process. Beyond the exploration phase, the number of Ghanaians directly employed by IOCs steadily increases while the number of expatriates decreases (figure 4.15). For example, Tullow and Eni employed together 454 Ghanaians and 162 expatriates in 2016.

**Figure 4.15: Direct Employment by a Major IOC**

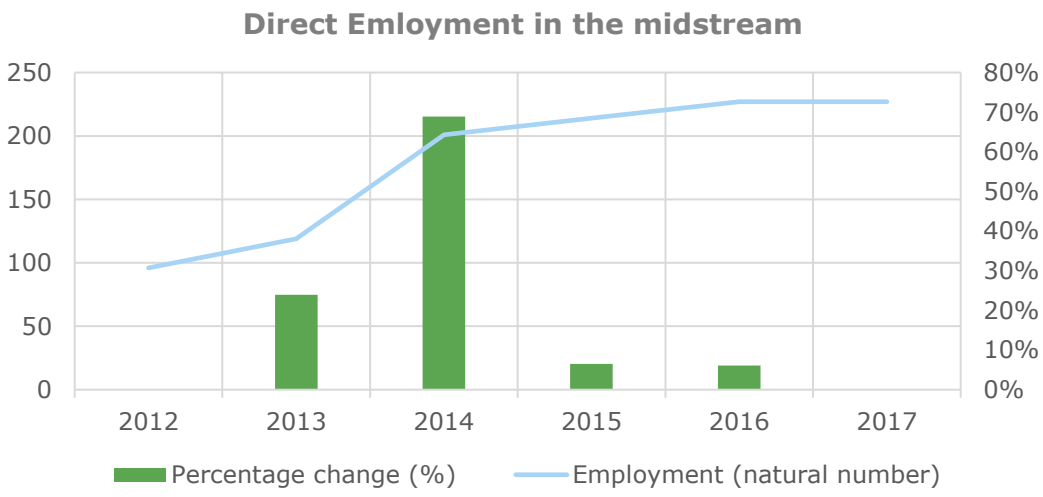



*Source:* Employment data collected and provided by a major IOC in the industry.

The jump in local employment between 2012 and 2013 could be attributed to the beginning of the construction phase of the TEN field. Ghanaians that had gained experience working alongside expats during the Jubilee development had acquired the know-how to enable them to be employed in the TEN construction phase. The same effect is observed in the development of Sankofa. Starting in 2013, just before the enforcement of the LCR, the number of positions filled by Ghanaians increased significantly, and this trend continued until 2017. IOCs mentioned that as the industry in the country matures, they would expect Ghanaian employees to hold 80 percent of the total direct employment in 2018 (the highest the sector has seen so far). Consequently, it seems that a combined effect of market forces (lower cost of Ghanaian employees versus expatriates) and LCR are leading this trend.

Although not subject to the LCR requirement (relevant only to upstream jobs), local employment in the gas midstream also increased significantly, driven by employment provided at the gas-processing plant and its pipeline (figure 4.16). Local employment increased by 70 percent from 96 Ghanaians in 2012, to 227 in 2017. This increase is a consequence of the commissioning of the Atuabo gas-processing plant in 2014 and the decision of GNGC to operate with 100 percent local employees.

**Figure 4.16: Direct Employment in the Gas Midstream sector**



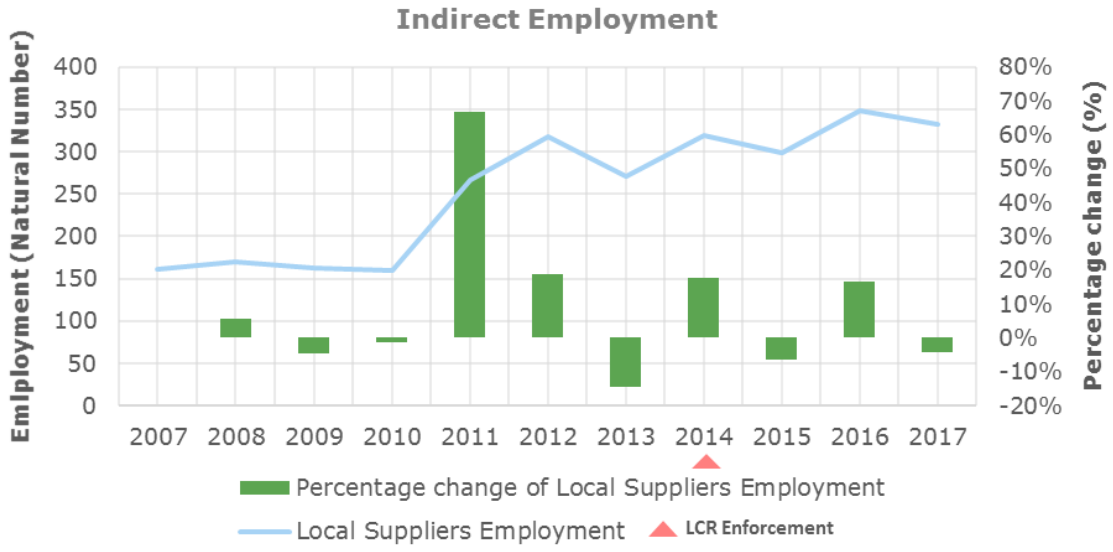
*Indirect Employment Effects*

Indirect employment in this context is defined as jobs originated by suppliers servicing the upstream value chain of the IOCs. The IOCs engaged in the development of the fields outsource some goods and services from local suppliers, which are mostly SMEs. Evidence on the jobs that they generate is therefore useful in assessing the indirect job impact of the three developments.

Indirect employment follows an increasing pattern (figure 4.17). Important growth is observed in indirect employment in 2011, which coincides with the launch of the development of the Jubilee phase 1A.[21] Although small in absolute numbers, the increase seems to outperform the rate of growth of the national employment by 3 percent for the period 2007–16.[22] However, the trend looks similar when comparing the period before (2007–13) and after (2014–17) the enforcement of the LCR. Overall, jobs in SMEs serving the oil and gas sector increase in line with the sector's overall growth.

Several local suppliers that responded to the study's survey expressed the view that the three oil and gas developments have significantly influenced the magnitude of their workforce overtime. Over 80 percent of the respondents mentioned that they only employ Ghanaians, and over half (52 percent) see a strong or very strong increase in their future employment figures, with only 11 percent seeing stagnation or reduction. Moreover, 37 percent of the survey respondents stated that they were optimistic in terms of employing more personnel for the oil and gas sector, with the rest stating that any future employment can be only partially attributed to the sector. It is difficult to interpret the optimism, as the respondents do not provide their underlying reasons; however, it could be speculated that this is partially linked to expectations of further sector growth in view of the recent rule of the Special Chamber of the International Tribunal of the Law of the Sea in favor of Ghana, leading to an end of the moratorium on drilling operations at Cape Three Points.

**Figure 4.17: Indirect Employment**



*Skills Development Effects*

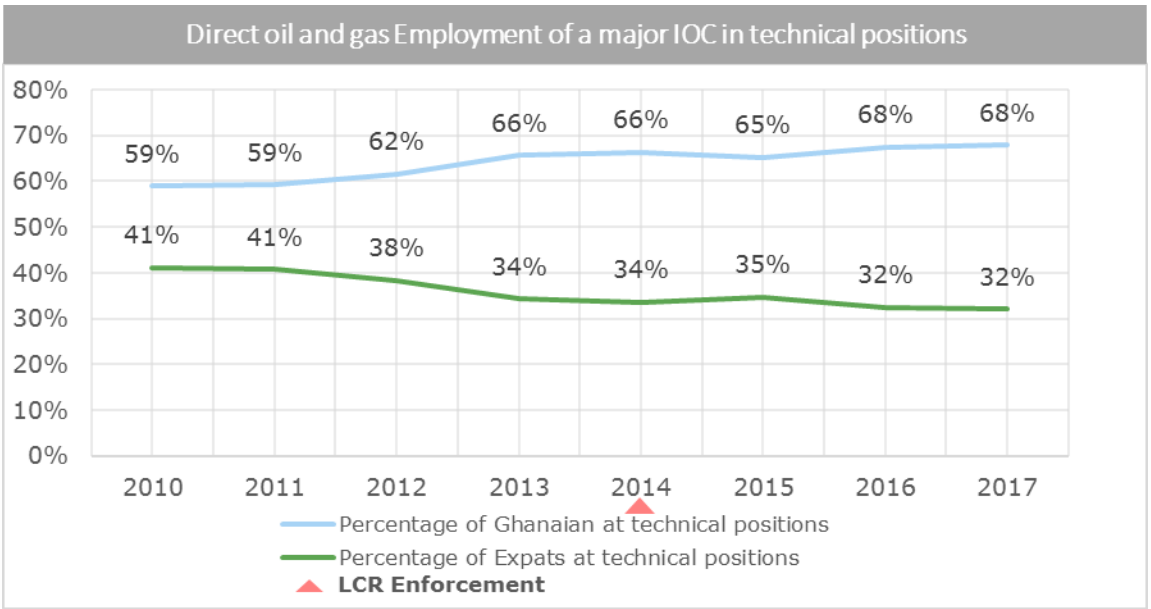
For developing countries like Ghana, skilled jobs are the "key to ending poverty and driving development" (Gonzalez 2017). They allow people to command higher pay and contribute significantly in terms of value added in the economy (IFC 2013).

Given that the industry was established in 2007, skills gaps are prevalent throughout in the upstream segment. Initially, all specialized and most of the nonspecialized services (appendix table I.1) were provided by expatriates (Palmade et al. 2017). This trend gradually reversed and is still evolving, given the industry's specialized skills requirements and recent establishment in the country. This is a challenging employment market to tap into by Ghanaians, not only because it requires high educational and training standards, but also because, for several jobs, it demands significant prior work experience in the same or similar positions.

Although the LCR promotes higher Ghanaian employment participation by setting specific targets for certain specialized job categories,[23] Ghanaians are mostly engaged in less specialized jobs, such as catering services and on-shore logistics. Moreover, a significant proportion of offshore logistics and health and safety services is filled by expatriates as local expertise is not available. For example, during the exploration phase, the study found that 97 percent of the workforce conducting seismic services were expatriates. Additionally, most of the management and highly specialized positions (for example, deck foreman, driller, and drilling superintendent) are also filled in by expatriates in the development and production phases.

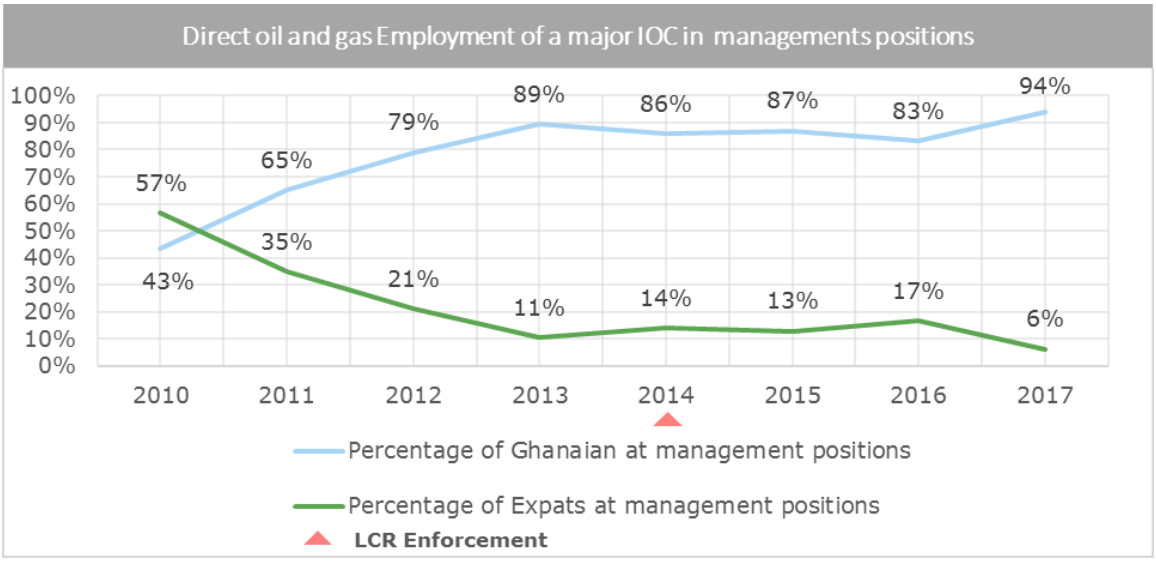
The evolution of Ghanaian employment in management and technical positions in a major IOC is depicted in figure 4.18 and figure 4.19. Management positions occupied by locals in the period 2010–17 (figure 4.19) follow an upward trend. This trend does not seem to be significantly affected by the introduction of the LCR. However, the percentage of Ghanaians in highly skilled technical jobs is much smaller (figure 4.18) than the percentage of Ghanaians in management. This is partly explained by the nature of the expertise needed for certain technical positions, which requires multiple years of on-the-job experience that only Ghanaians working overseas could bring to the country. As the sector matures and more Ghanaians gain experience in the sector, IOCs will have available a larger pool of potential candidates.

**Figure 4.18: Direct Oil and Gas Employment of a Major IOC (technical positions)**




*Source:* Employment data collected and provided by a major IOC in the industry.

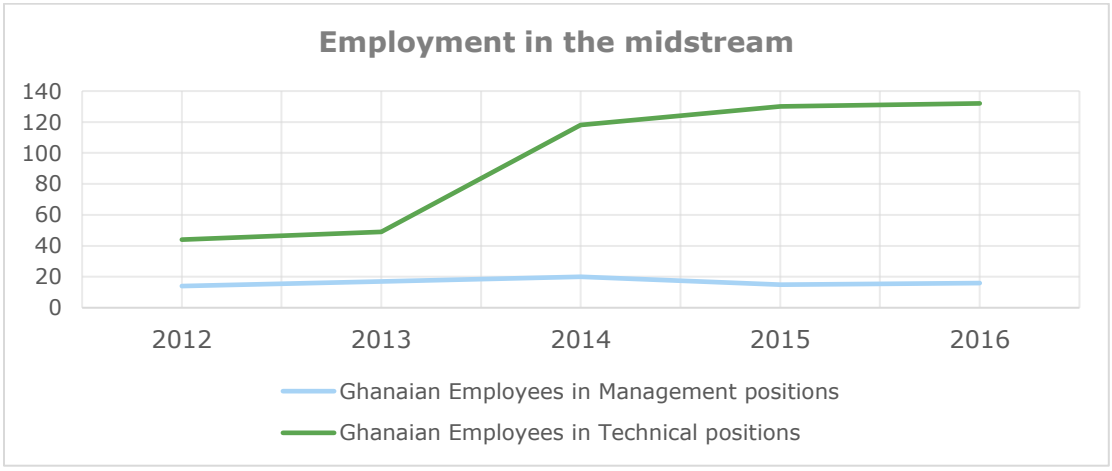
**Figure 4.19: Direct Oil and Gas Employment of a Major IOC (management positions)**




*Source:* Employment Data collected and provided by a major IOC in the industry

The operational phase of the small and newly established natural gas midstream segment is 100 percent staffed by Ghanaians; expatriate personnel were hired only during the construction phase of the processing plant (Ghana Gas 2017). The number of management positions held by Ghanaians averaged 17 in 2012–16, with small variations. However, the number of technical positions held by Ghanaians increased significantly over the same period (more than tripled after 2014). These figures are explained by the start of the operations phase of the Atuabo gas processing plant in 2014 (figure 4.20).

**Figure 4.20: Ghanaian Employment in the Midstream (number of management and technical positions)**




*Source:* Employment Data collected and provided by Ghana Gas (Ghana National Gas Company)

*Education and Training Effects*

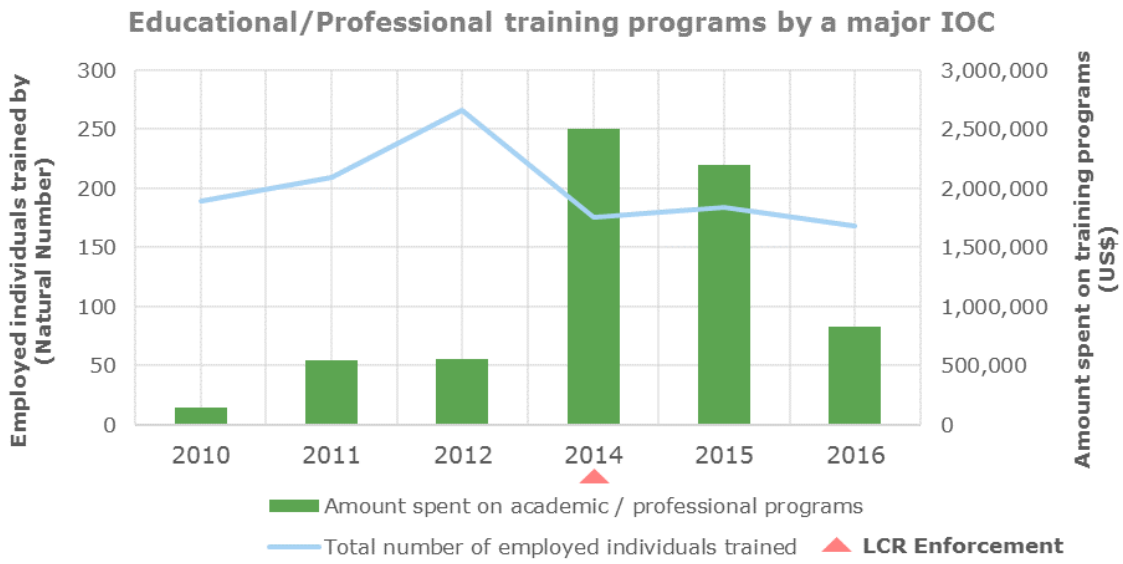
Initiatives focused on education and hands-on training were developed to mitigate skills gaps. As the LCR requires companies to progressively substitute expatriates with Ghanaians, they are required to report their hiring and training plans and budget, including a forecast of skills needed going forward. As the sector is new, on-the-job training was typically not accessible to

Ghanaians. Therefore, companies were compelled to implement practices such as "shadowing" expatriates performing specialized technical jobs, so that Ghanaians could acquire the necessary experience to meet the position's requirements once the expatriate departs and hands over the responsibility.

Figure 4.21 presents information on training expenditure and the number of people trained, provided by a major IOC from 2010 to 2016. Training expenditure was in the range of 0.16 percent to 0.61 percent of total annual operational expenditure in that period. The number of employees participating in training programs peaked in 2012, as more employees were trained in the early years of the sector's development.

However, training expenditures grew significantly only after 2013, probably due to the following two reasons: (i) investment in training courses and overseas scholarships for Ghanaians became progressively costlier because the number and complexity of required skills grew with the development of the fields (Tullow Oil 2014), and (ii) the LCR officially began 2014, requiring IOCs to invest more in developing local staff.

**Figure 4.21: Educational/Professional Training Provided by a Major IOC (expenditure and number of persons trained)**

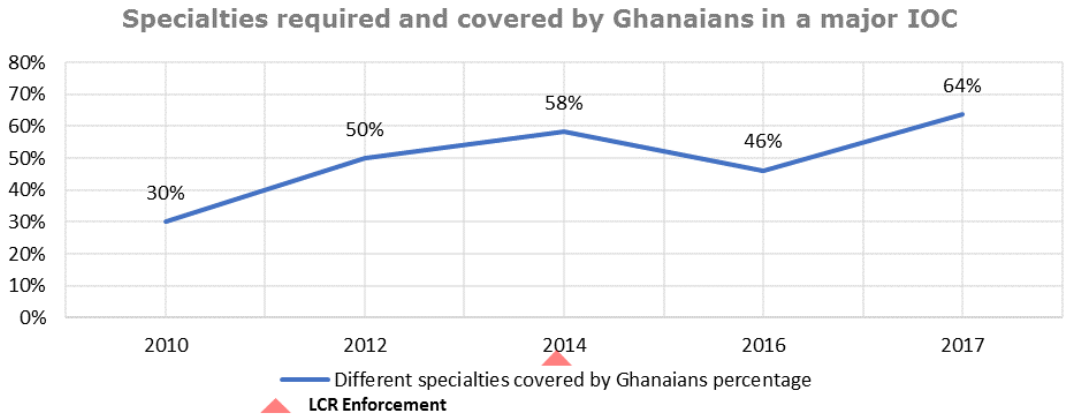



*Source:* Training data collected and provided by a major IOC in the industry.
*Note:* Data for 2013 were not available.

Figures 4.22 shows the percentage of different specialties covered over time by Ghanaians, based on data provided by a major IOC operating in the country. Less than 30 percent of the skills required could be adequately covered by Ghanaians in 2010. This percentage increased significantly thereafter to an average of 50 percent in 2012–16 and reaching 64 percent by the end of second quarter 2017.[24]

Several privately and publicly funded programs were set up to address skills gaps. Some of these programs aimed at developing the technical and safety skills of young professionals and graduates from Ghanaian institutions, while others focus on building the capacity of local education institutions. Finally, there were a few programs that provided scholarships for Ghanaians to study overseas and/or gain hands-on experience as trainees in more developed company operations in other countries. More details on training and education programs can be found in appendix M.

**Figure 4.22: Proportion of Required Specialties required Covered by Ghanaians over Time**




*Source:* Employment data collected and provided by a major IOC in the industry.

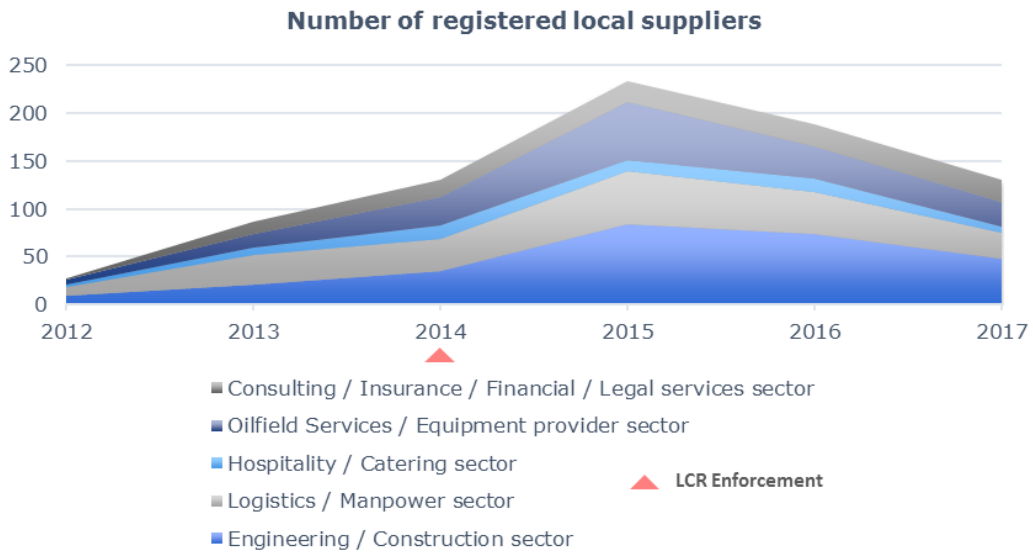
## Local-Supplier Effects

This section discusses how local companies' participation evolved over time in the upstream segment, with a focus on the number of registered and active suppliers, the breadth and share of goods and services offered by local suppliers, contracted amounts, capacity development, and constraints faced by local suppliers.

*Registered Suppliers*

Since 2014, and following the LCR requirements, local and foreign companies willing to provide goods and services to the oil and gas sector are required to register annually with the PC (and pay a significant fee) across various categories depending on the focus or foci of their business, for example consulting, insurance, oilfield services, and logistics (figure 4.23). The number of registered suppliers peaked in 2015 and since then has been steadily decreasing. This is possibly due to the high expectations of business created by the introduction of the LCR in 2014, expectations that did not further materialize due to reasons explained in the following paragraphs.

**Figure 4.23: Registered Suppliers with the PC (2012–17)**

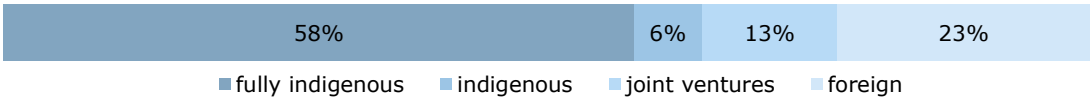



*Source:* Petroleum Commission.

Although detailed statistics on SMEs are not readily available and the PC does not provide information on the proportion of registered suppliers which are SMEs, it can be reasonably assumed that most of them are.[25] There are two reasons for this assumption. First, this is the consensus among the numerous stakeholders interviewed for the study. Second, 92 percent of companies registered by the Registrar General Department of Ghana are SMEs,[26] with 85 percent of them being SMEs, primarily in the private sector[27]. As the definition of an SME varies across official sources, this study uses as a reference the *World Bank 2013 Enterprise Survey for Ghana* definition that is based on staff headcount.[28]

In terms of ownership, over 60 percent of the registered suppliers are fully indigenous and indigenous companies, 13 percent are joint ventures of local and foreign companies, and 23 percent are foreign companies (figure 4.24). According to the PC, an indigenous Ghanaian supplier is a company with at least 50 percent of its equity owned by a citizen of Ghana, with Ghanaian citizens holding at least 80 percent of executive and senior management positions, and 100 percent of nonmanagerial and other positions (Darvas and Palmer 2014). A fully indigenous supplier is a 100 percent Ghanaian-owned company.

**Figure 4.24: Ownership Categorization of Registered Suppliers, 2017**




*Source:* Ghana Supply Chain Development Program "Empower," Newsletter, issue 5, May 17, 2017.

*Note:* Verbatim from newsletter: "In his speech, Mr. Abdul-Karim Adam, Local Content Development Professional at Petroleum Commission, highlighted that through Local Content activities, 840 companies comprising of 488 fully indigenous, 52 Indigenous, 105 Joint Ventures and 195 foreign companies have taken opportunities in the Upstream Sector." Available at: https://www.ghanalinks.org/documents/20181/0/USAID+Ghana+Supply+Chain+Development+Program+Newsletter%2C+May+2017/0011d836-edd0-44df-ad54-68d2085f04a6?version=1.1

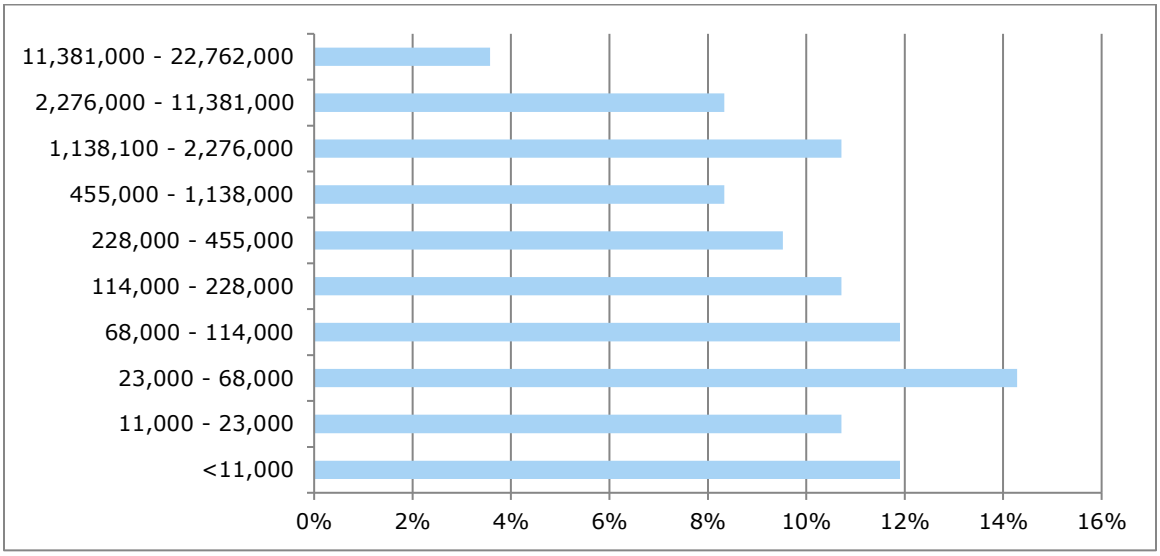
*Active Suppliers*

Although the information on active suppliers is typically not tracked as closely as the information on registered suppliers, several pieces of evidence appear to indicate that they are a significant smaller subset of the number of registered suppliers.[29]

For example, approximately 230 companies were registered with the PC in 2014, and only 150 of them (65 percent) were reported in statements by PC officers as providing direct and/or indirect services to the upstream.[30] In another example, the SME survey conducted for this study revealed numerous nonoperational e-mail addresses relating to registered suppliers (over 39 percent). As the study discusses below in the section on constraints for local suppliers, these suppliers faced challenging constraints to serve the sector. The PC, the National Chamber of Commerce, and the Sekondi-Takoradi Chamber of Commerce were not able to provide precise information on the population of active suppliers, but they emphasized that it is only a fraction of the registered companies.

In terms of revenues, Invest in Africa assessed 84 active suppliers in the oil and gas upstream (figure 4.25), which represent roughly 21 percent of the potential prospect population of SMEs as assessed by the study (primary research July 2017). Roughly 75 percent of these companies' annual revenues are below US$1.15 million, and almost 12 percent of them have annual revenues lower than US$11,000. Their focus is on engineering services (39 percent of the sample), logistics (27 percent), clearing and freight forwarding (11 percent), inspection services (8 percent), personnel recruitment services (5 percent), and waste management, facility management, transport and catering (each representing 2.5 percent of a sample of 84 local SMEs).

**Figure 4.25 Annual Sales for a Sample of 84 Local Companies (US$)**




*Source:* Invest in Africa.

*Goods and Services*

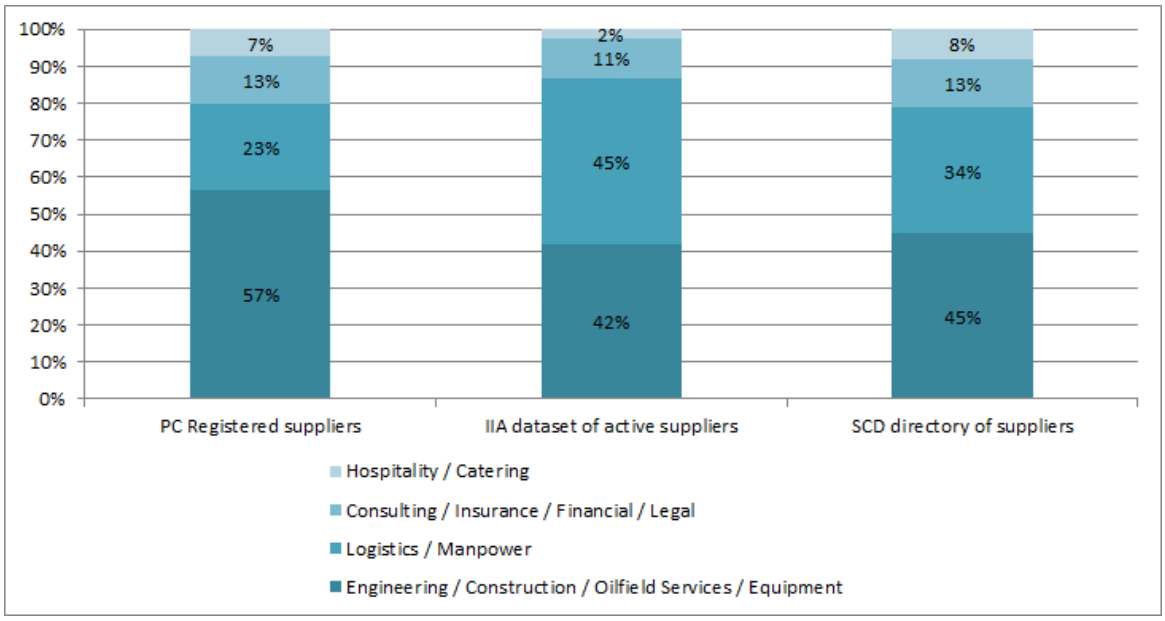
It should be noted again that equipment purchased from Ghanaian companies (with over 51 percent Ghanaian equity) is typically imported in most cases.

Before the Local Content Plan (LCP) regulation (2014), IOCs and their international suppliers procured some sector specialized services from local suppliers, such as customs clearing, local transport, lifting equipment (for example, cranes and forklifts), water, food, fuel, and travel agency services. Additionally, other nonspecialized services were provided locally such as civil engineering, construction, metal fabrication, and welding, because these capacities were developed by suppliers to the more seasoned Ghanaian mining sector and transferred to the oil and gas sector.

After the LCP regulation, certain goods and services were reserved to local suppliers only: for example, catering, logistics, welding and fabrication services, vessel services, and freight forwarding. Currently, the companies registered with the PC offer engineering and/or construction activities (33 percent); logistics and/or manpower services (27 percent); oilfield and/or equipment services (21 percent); consulting, insurance, financial, and/or legal services (12 percent); and hospitality and/or catering activities (7 percent).[31]

The largest proportion of services provided by local suppliers is related to engineering and logistics due to the requirements of the LCP regulation (figure 4.26). This is evidenced by comparing 2016 information from the PC, Invest in Africa, and the Supply Chain Development Program (SCD).[32] According to testimonials obtained through from stakeholders' interviews and the study's SME survey, most SMEs service the IOCs directly or indirectly through the provision of services to oilfield service companies and foreign contractors (see appendix L).

**Figure 4.26: Share of Local Suppliers by Type of Service and Proportion of Suppliers, 2016**

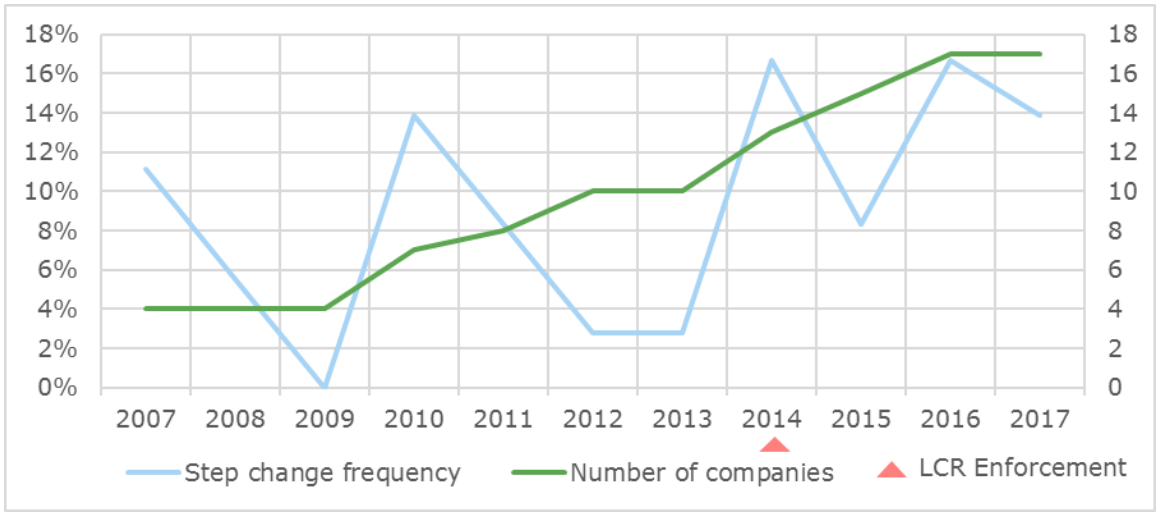



*Source:* Petroleum Commission (PC), Invest in Africa (IIA), and Supply Chain Development Program.

*Share of Goods and Services*

According to the SMEs surveyed, the share of the products and services that they sell to the upstream follows an upward trend. These SMEs were asked to report annually the proportion of goods and services that they provided to the oil and gas sector. The average percentage is larger in 2014–17 than in 2007–13, as these companies gradually built their capacity and the mandatory local content requirements came into force in 2014 (figure 4.27). "Number of companies" represents the number of companies that responded that they provided goods and services in each year; meanwhile, "Step change frequency" represents the frequency with which the companies that responded that they had served the sector switched to a higher or lower bracket in the five brackets allowed by the questionnaire.[33] The former seems to hint at a more sustainable level of business provided by these companies to the sector over time.

**Figure 4.27: Proportion of the Total Goods and Services Provided to the Oil and Gas Sector by a Sample of Local Suppliers**



*Contracted Amounts*

The amounts contracted to local suppliers follow an upward trend from 2010 to 2016 (table 4.16), particularly in the past two years, as observed through data provided by the PC on six major IOCs operating in the country.[34] In general, both the total services and the foreign services follow the development cycle of the several oil and gas fields discovered. The discovery of the TEN field and the *Jubilee Phase 1A Development Plan* are responsible for the peak in 2011–12. Meanwhile, the development of TEN and Sankofa are responsible for the peak in 2015–16, as well as any potential cost inflation connected to the enforcement of the LCR.

**Table 4.16 Contracted Amounts by IOCs Operating in Ghana (US$ million)**

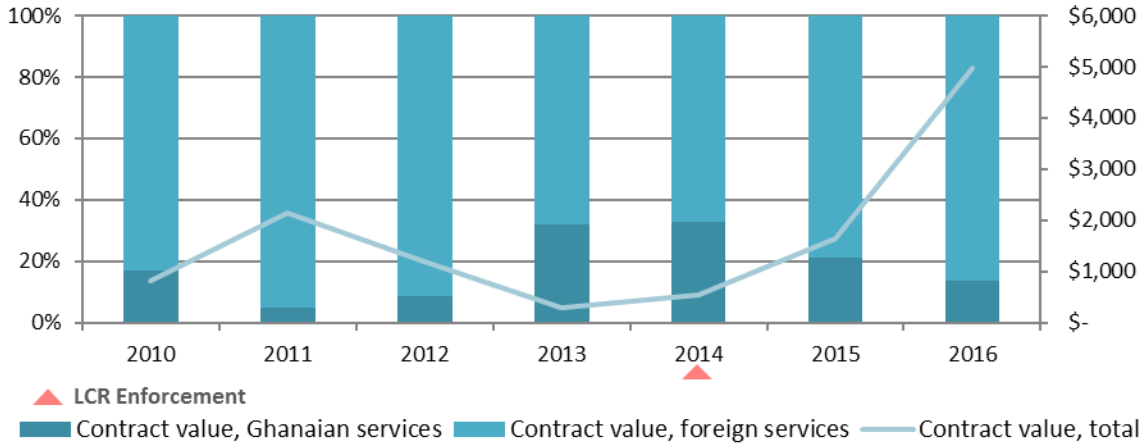
| Contract value | 2010 | 2011 | 2012 | 2013 | 2014 ▲ | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| **Ghanaian services** | 140 | 104 | 102 | 90 | 177 | 347 | 671 |
| **Foreign services** | 687 | 2,054 | 1,101 | 193 | 363 | 1,292 | 4,311 |
| **Total contract value** | ***827*** | ***2,157*** | ***1,203*** | ***284*** | ***539*** | ***1,639*** | ***4,982*** |

▲ LCR Enforcement

*Source:* Petroleum Commission.

However, the proportion of total contracted amounts to local suppliers increases since 2010, peaks in 2013–14,[35] and then decreases thereafter from 33 percent in 2014 to 21 percent in 2015 and to 13 percent in 2016 (figure 4.28). The high overall contract value in 2015–16 is likely related to large technical construction items, which are usually internationally sourced. Several overlapping events explain these changes in the proportion of locally contracted amounts. These include the development cycles of the oil and gas fields; the enforcement of the LCR since 2014, the outcome of the capacity-building efforts such as the Enterprise Development Center (EDC) and the SCD, and the limited overall capacity of the Ghanaian upstream value chain to keep the pace of the development of the oil and gas fields.

**Figure 4.28: Contracted Amounts, Local and Foreign Services, Six IOCs (2010–16) (US$ million)**




*Source:* Created based on data provided by the Petroleum Commission, 2017

Although the rate of growth of the amounts contracted with local suppliers by the IOCs changes both positively and negatively over time, its average annual growth rate in 2011–16 is positive and in the 16–25 percent range (table 4.17).

**Table 4.17: Growth Rate of Amounts Contracted to Local Suppliers (% change, CAGR 2011–16)**

| Growth (%) | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | CAGR |
|---|---|---|---|---|---|---|---|
| Six IOCs (PC) | -26% | -1% | -11% | 95% | 97% | 93% | 25% |
| One IOC (study) | 22% | 2% | -2% | -1% | 82% | 31% | 16% |

▲ LCR Enforcement

*Source:* Data provided on six IOCs by the Petroleum Commission (PC) and by a major IOC operating in Ghana.

*Note:* CAGR=Compound Annual Growth Rate

However, the proportion of goods and services provided by local suppliers and produced in the country is significantly smaller. The most frequent responses from SMEs to the survey conducted for this study help to shed some light on this. When these SMEs were asked about the proportion of the goods and services produced locally, the most frequently chosen responses were "100 percent" as well as "between 11 percent and 30 percent" and "less than 10 percent." The SMEs providing nontradable goods were more likely to be in the highest bracket, while the SMEs providing tradable goods were more likely to be in the two lowest brackets.[36] For example, local suppliers hire overseas subcontractors and import goods that they in turn sell in Ghana to the oil and gas sector.

Moreover, oilfield service providers estimated that the ratio of imported-to-domestic goods in the sector could be as high as 90:10. For example, a local supplier providing subsea services chartered a vessel from a Norwegian company. Consequently, 60–90 percent of this local supplier's cost is spent overseas. In another example, local steel suppliers import the steel and are subject to import tax (on a per kilo of steel basis). This situation creates incentives to prefabricate the steel abroad, because in this way they reduce to the amount of steel that they import so they ultimately pay less import tax.[37]

*Capacity Building*

Several public and private initiatives and institutions have been set up for the support of SMEs and the promotion of entrepreneurship in Ghana, some of which are specifically relevant to companies wishing to be involved in the country's oil and gas sector. IOCs operating in Ghana have provided direct support as well as implementing their own programs to facilitate local SME participation. The major initiatives and organizations for the development of SMEs include the EDC, the Supply SCD, the Association of Ghana Industries (AGI), IIA, and the National Board for Small Scale Industries (appendix M). The EDC and SCD deserve more attention, because they often serve as the main entry point into the oil and gas industry for inexperienced SMEs.

Established in 2013 in Takoradi, the EDC is a joint initiative of the Ministry of Energy and Petroleum, the Ministry of Trade and Industry, and the Jubilee partners. It was established with a US$5 million budget with the objective of providing capacity-building support to Ghanaian SMEs so they can position themselves to take advantage of opportunities in the oil and gas industry upstream, promote collaboration among SMEs, and coordinate third party support for SMEs where necessary. Among the services the EDC provides are business training, advisory services, and access to markets and information. It also has acted as a focal point for coordination between SMEs and oil and gas companies, their contractors and subcontractors. As of July 2014, six businesses that had completed the EDC training had been awarded contracts by IOCs and service companies.[38] Some of these had experience from working with Ghana's shipping and mining industry; such companies tend to have a comparative advantage over new entrants (Ablo 2015).

The SCD program has provided services to about 250 companies to date. Currently, 100 companies are actively engaged and receive training every month, and 72 contracts ($18.5 million) were awarded to them between 2014 and 2017. The SCD conducted a gap analysis in 2017, which provides a contemporary snapshot of the training needs identified by stakeholders in the industry (table 4.18). They include a wide array of capacity-building needs for potential local suppliers including those in business, financing, health, safety, environment, technology, and management.

**Table 4.18: Skills Gap Analysis of Ghanaian Companies by SCD (2017)**

| **Strategic and/or Business Planning** | **83%** | **Standards and Certifications** | **60%** |
|---|---|---|---|
| **Risk Management and Compliance** | 78% | Procurement | 60% |
| **Health, Safety and Environment** | 75% | Leadership | 55% |
| **Bid and Proposal Support** | 75% | Operations Management | 55% |
| **Market Research** | 68% | Financial Planning and Management | 53% |
| **Costing and Pricing** | 68% | Technology and Information Management Systems | 53% |
| **Quality Management** | 68% | Supply Chain Development | 48% |
| **Networking Skills and Opportunities** | 68% | Taxation | 45% |
| **Access to Finance** | 65% | Human Resources | 40% |
| **Sales, Marketing and Communications** | 63% | International Accounting | 38% |
| **Information on Procurement Opportunities** | 63% | Other | 5% |

Primary research conducted for this study provides evidence of some early successes of these capacity-building efforts:

- Operations such as build, repair, and clean tanks/vessels, as well as certain types of underwater maintenance, are now provided by local companies. Some of these skills are also transferable to other links of the supply chain.
- Certain parts of the TEN FPSO were manufactured locally, as opposed to the Jubilee FPSO (which was the first FPSO used in Ghana) that was almost entirely fabricated abroad. This contributed to the development of indigenous welding and fabrication capacity.
- An indigenous company is now providing subsea installations directly to several IOCs. It started as a joint venture with a foreign company, but it is now operating on its own and employs a few expatriates.
- New requirements have given rise to new markets: the local sector responded to the transportation needs of the installation of subsea equipment by providing helicopter services, which did not exist prior to 2007.

### Constraints for Local Suppliers

Local companies face significant constraints to growth in Ghana, despite relatively good business environment rankings. This is compounded by the fact that most expenditure in the upstream oil and gas sector is heavily biased toward highly complex goods, thus reducing the scope for backward links and local participation opportunities in a country with a low sectoral skill base (CCSI 2016). Good governance has supported the improvement of the business environment

with Ghana performed better than the regional Sub-Saharan average and regional peers (for example, Nigeria and Côte d'Ivoire) in terms of ease of doing business in 2017 (World Bank 2017) and improved its position compared to the previous two years.

Through literature review and primary research, this study assessed the following challenges for local suppliers in the oil and gas sector:

- Access to finance
- Access to business information
- Stringent technical and quality standards
- Limited local capacity for and high costs of doing business
- Small size of the domestic oil and gas market
- Weaknesses of current industrial policies.

*Access to finance* is one of the major challenges facing SMEs and local suppliers in the oil and gas industry. Procurement guidelines and contract sizes in many cases demand a level of financial capacity that local companies cannot readily meet. For example, SMEs do not seem to be able to provide collateral of the kind acceptable by banks. Although Ghana has a high "getting credit" score by the World Bank (44 of 190), overall access to finance has a low score owing to high interest rates. The interest rate typically paid is in the range of 35–40 percent, and this can often act as a deterrent in applying for financing as local businesses believe they would not be able to afford repayment.[39]

*Access to business information* is limited because SMEs typically rely on social, political, ethnic, and sometimes religious networks to access information and win contracts. Many SMEs with the potential and knowledge to service the upstream have insufficient access to information on available business opportunities. For example, information related to tenders by IOCs is not easily accessible, and the tender process is bespoken to each IOC. Additionally, platforms set to serve the purpose of bringing together SMEs with business opportunities in the sector fit better the needs of well-established medium- to large-scale Ghanaian enterprises, limiting the entry opportunities for new and small local businesses (Ablo and Overå 2015). According to a survey carried out by the IIA (2014), respondents pointed to a widening communication gap between multinational companies and SMEs. They assigned responsibility for this gap to the IOCs who. according to the respondents. failed to make their tender processes more accessible to a wider group of potential local suppliers. Initiatives such as the SCD, the EDC and the IIA's African Partner Pool try to bridge the gap. There are also examples in other countries that could be potentially benchmarked on information exchange platforms in the upstream oil and gas sector.[40]

*Stringent technical and quality standards* demanded by the oil and gas industry pose significant challenges to the development of the sector. On the one hand, local suppliers often lack the technical skills and capacity to meet these standards. On the other hand, IOCs and oil service companies face challenges in fulfilling their local content obligations given the lack of these local capacity and skills. The industry demands that suppliers comply with health, safety, and environmental (HSE) standards and technical specifications, as well as up-to-date industry knowledge, technologies, and internationally recognized certifications.[41] Poor access to credit constrains the capacity of local suppliers to obtain these international certifications and to have access to these technologies.

Successful examples of compliance are two Ghanaian companies: Seaweld Engineering (welding and fabrication, procurement and logistics, onshore and offshore labor), and Macro Shipping (ship agency, freight forwarding, haulage, and oil and gas projects). These two indigenous

Ghanaian companies have received training from programs run by Tullow since 2009 and consequently developed specialized capabilities to directly service the upstream sector.

*Limited local capacity and the high cost of doing business* result in uneven competition between local and international suppliers. Often, IOCs and oil services companies make bulk purchases of equipment through purchasing agreements that address their global needs (to increase their bargaining power). This makes competition tougher for local suppliers despite the LCR protection based on price and type of goods and services: (i) if the value of the bid of a qualified indigenous Ghanaian company does not exceed the lowest bid by more than 10 percent, the contract shall be awarded to that indigenous Ghanaian company and (ii) the goods and services that only indigenous qualified Ghanaian companies are allowed to provide include catering, freight forwarding, logistics, vessel services, welding and fabrication services. Additionally, as contract sizes in the upstream tend to be large, SMEs often do not have the capacity to deliver on them.

According to a recent AGI Barometer report, surveyed companies report high costs of doing business and credit as constraints for their operations (AGI 2017). Cost constraints include the cost of utilities (electricity and water), followed by the multiplicity of taxes and the cedi depreciation. These are mentioned by the top three businesses across the sectors covered by the AGI Barometer survey—manufacturing, services, and construction—and by businesses of all sizes. Indeed, accessing electricity and paying taxes are also found among the three lowest scores among indicators in the World Bank's Doing Business 2017 survey (120 and 122, respectively). The cost of registering with the PC and paying an annual renewal fee is also seen by SMEs as a significant burden.[42] For this reason, Ghanaian suppliers are advised to consider joint ventures to enable them to become more competitive. The idea behind this is that SMEs coming together as partners in delivering a contract can create the necessary conditions to deliver larger contracts at an unforbidding cost.

*The relatively small size of the domestic oil and gas market* is also a significant issue for the development of the sector and a competitive suppliers' base. The sector does not yet support the development of local specialized goods and services to a point where they could achieve economies of scale in the local market (and become competitive internationally). Certain IOCs deem that the advanced state of development of the three fields, as well as the depressed global oil price, further undercut the development of a local supply industry and that this situation could be reversed only if new fields were developed.

*Weaknesses in current industrial policies* are behind many challenges to increasing local content and value addition, according to a 2017 study by the African Center of Economic Transformation (ACET 2017). Government regulations are often overly strict and achieve suboptimal results. For example, there is a strong focus on the shareholding structure as a criterion to define a "local" supplier, instead of metrics such as origin of goods and services, local employment, and local value added. Indeed, instances of "fronting"—misrepresentation of the facts of a company's ownership—have been reported as a common occurrence. Legislation prescribes a limit to management positions that can be held by expatriates within a set period. Within this period, companies must enact an organized succession plan for local management. Similarly, there is a set period and prescribed quotas for local procurement. In this context, foreign companies use local companies as a cover to take advantage of benefits afforded to local companies. This undermines local content efforts and is now considered a criminal offence in Ghana (BAL 2016).

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## Notes

[1] The FPSO was produced in Singapore; the key skilled labor has been provided by the United Kingdom; subsea trees and other equipment is from the United States, France, and Norway; and gas compression is from Thailand. This number is also consistent with the findings derived from the onsite analysis and the statistics regarding the ration of imported to total supply that characterise the industries that were involved in the construction of the oil and gas fields.

[2] Throughout the text, model results are commonly reported for the 2015–30 period. However, in the section describing the stages, it is necessary to separate the short-term (2011–17) from the long-term effects (2018–30).

[3] Maintenance jobs belong to the operation phase; hence; they are not considered in Stage 1.

[4] Consequently, the Jubilee, TEN, and Sankofa fields become operational in Stage 2.

[5] The energy security index $\left(\frac{Imported\ Energy}{Total\ Energy\ Demand}\right)$ improves by 20 percent in Stage 2 compared to the Reference Scenario.

[6] The study assumes a transition to rates that better reflect electricity costs in Stage 2.

[7] Industrial energy costs include the weighted cost of electricity from grid and fossil fuels (i.e. diesel, gas).

[8] The construction of infrastructure has a smaller impact than the use of infrastructure.

[9] This is in line with other studies that note such scenarios may increase "average consumption of the wealthiest group increased by 27% between 2006 and 2013, whereas for the poorest increased by 19%" Cook, Hague, and McKay 2016).

[10] In terms of income inequality, the Gini coefficient increased from 37 in 1992 to 42.3 in 2013. Based on Bastagli and Coady (2012), Ghana has the fastest income inequality growth rates in Africa. Note also that stimulated demand increases imports.

[11] As opposed to the permanent productivity effects that the upgrade of infrastructure brings to the economy in the Full Scenario.

[12] See the government of Ghana's "Sowing the Seeds for Growth and Jobs: 2017 Ghana Budget Highlights."

[13] For the second channel to be operational, human capital needs to be matched with installed physical capital and investments, otherwise there will be a skills mismatch. The role of education in economic growth and labor productivity has been widely studied,

especially in developing countries. Despite strong theoretical and empirical evidence that education increases labour productivity, the relation between education and economic growth is not universal (World Bank 2008, ch. 2).

[14] The new policy scenario according to IEA "takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced."

[15] Per IEA, "The 450 scenario sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of $CO_2$."

[16] Both the Full Scenario and the Reference Scenario were quantified with projected oil and gas prices taken from the IEA 2016 ("Current policies scenario").

[17] For a detailed description of the oil and gas value chain, see appendix H.

[18] Although the language may resemble a before-and-after evaluation design, the study does not pretend to assess any attribution to the local content law. The reasons for this are twofold: the local content law is very recent, and the effects of the local content law cannot be delinked from other economic effects.

[19] *Source:* GEM E3M results

[20] Analysis on employment data provided by the Statistical Service of Ghana.

[21] The Jubilee Phase 1A development project, designed to increase production and recover additional reserves, was approved by the government of Ghana in January 2012. Phase 1A consisted of eight additional wells, which included five producers and three water injectors.

[22] From the Statistical Service of Ghana Statistical and study survey data. Five percent compounded national employment growth rate versus 8 percent compounded for oil and gas local supplier's employment growth rate.

[23] Categories defined as technical core staff including engineers, technicians, geoscientists; management staff consisting of the chief executive officer, general manager, managing director, country manager, president, heads of departments; and unskilled staff (see appendix I).

[24] There are some variations along the upward trend, subject to different phases of different field developments.

[25] The Ghana Statistical Service recently ran a business survey of SMEs across sectors, including both formally registered companies and unregistered companies, such as small distributors of LPG canisters or cylinders for cooking. The results of the survey were not available to inform this study.

[26] "Empowering SMEs in Ghana for Global Competitiveness," eServices Portal of the Government of Ghana, http://www.eservices.gov.gh/Pages/Empowering-SMEs-in-Ghana-for-Global-Competitiveness.aspx accessed July 2017.

[27] International Trade Center (2016). SME Competitiveness in Ghana: Alliances for Action. ITC, Geneva

[28] The same definition is used by the 2016 SME competitiveness survey carried out by the Association of Ghana Industries (AGI) and the International Trade Center (ITC). According to these definitions, a company is characterised as small when it employs up to 19 employees, medium when it employs between 20 and 99 employees, and large when it employs 100 or more employees.

[29] The PC, the National Chamber of Commerce, and the Sekondi-Takoradi Chamber of Commerce were able to provide precise figures. However, they all emphasized that the number of active suppliers was a fraction of the registered suppliers in the sector.

[30] Petroleum Commission's new local content law strategy. (2014). [Blog] *Delegation of German Industry and Commerce in Ghana*. Available at: http://ghana.ahk.de/news/single-view/artikel/petroleum-commissions-new-local-content-law-strategy/?L=14&cHash=111c3750066af1cc5f68f0ec6f016b44 [Accessed 21 May 2018].

[31] Petroleum Commission, primary research 2017.

[32] The SCD is an initiative funded by USAID, working with local SMEs on sector-relevant capacity building (for more details see appendix K)

[33] Companies where asked to respond to the question "How has the proportion of goods/services provided to the O&G sector by the company changed overtime?" using one of the following responses, for each year between 2007–2017: less than 10%, between 11% and 30%, between 31% and 50%, between 51% and 70%, between 71% and 90%, over 90%.

[34] The information provided has been derived from local content reports to the PC by Tullow, Eni, Lukoil, Hess, Medea, and Kosmos, from 2010 to 2016. The number of companies reporting per year is not constant (PC pers. comm. 2017)

[35] 2014 is the year of local fabrication of the TEN FPSO supporting structures, and the start of production of associated gas from the Jubilee field which fed into the local commercial gas supply chain.

[36] The Petroleum Commission intends to start a program of audits to ascertain the proportion of the value that actually stays locally from contracts with Ghanaian companies.

[37] They do not pay taxes on the steel wasted in the prefabrication process.

[38] The EDC was operational until 2016; however, the most recent data that we were able to be retrieved were of 2014.

[39] Additionally, according to Ablo (2015), SMEs are required to have annual turnover twice the value of the contract they wish to execute, making the financing constraint even more relevant in the context of high-value contracts in the sector.**?**

[40] See, for example, GIZ 2016, Box 2.3," The Role of Companies, Government and International Development Cooperation."

[41] HSE compliance is a major constraint given the limited adherence to safe practices in the Ghanaian market. IOCs typically provide company-specific training to ensure that the SMEs comply with their standards.

[42] The fees and charges schedule can be found on the Ministry of Energy website, http://www.energymin.gov.gh/sites/default/files/0-Petroleum-Commission_-%28Fees-and-Charges%29.pdf. These are subject to the type of services and the size (turnover) of the company applying for the license.

# 5. CONCLUSIONS AND RECOMMENDATIONS

The recent discoveries of oil and gas in Ghana have the potential to boost economic growth, but their ultimate growth impact will depend on the type of policies implemented by the government going forward. As explained, oil production started in December 2010. Proven oil reserves are estimated at 1.1 billion barrels, while proven gas reserves are estimated at 2.1 trillion cubic feet. Oil production is projected to peak at 236,290 barrels per day, and gas production is expected to average 323.7 million cubic feet per day. The Petroleum (Local Content and Local Participation) Regulations (LI 2204) were enacted in November 2013 and enforced only since February 2014.

The immediate effect of the development of the oil and gas fields was the diversification of exports from two commodities (gold and cocoa) to three commodities with the addition of crude oil. Currently, gold, cocoa, and crude oil account for about 70 percent of total exports; therefore, the economy is still exposed to commodity-price variability. Imports span a wide range of products and capital goods, which reflect the low industrialization level of Ghana.

This section discusses the main emerging conclusions from the study and formulates several recommendations for Ghana and the development community. Finally, suggestions are made in terms of potential follow-up research.

**Main Emerging Conclusions**

*Potential Effects on the Economy*

- The GEM-E3-G model (Full Scenario) estimated positive effects on GDP in the long term (2015–30) due to the development of the oil and gas fields,[1] and the multiplier effect would be much larger on gross domestic product (GDP) than on employment. As oil revenues are used to upgrade infrastructure, both labor productivity and competitiveness of the economy increase. As productivity increases, income increases, but fewer labor hours are needed per unit of output.
- The model quantified GDP growth of 6.5 percent over 2015–30, driven by 7.3 percent growth in exports, 4.8 percent growth in investment, 6 percent in growth in household consumption, and 5 percent growth in imports. GDP growth depends on the use of public oil and gas revenues to upgrade infrastructure and a smooth and coordinated development of the energy sector.
- Moreover, GDP growth in excess of the Reference Scenario is estimated at approximately US$74 billion (2015–30), and oil and gas government revenues are estimated at approximately US$21 billion (2015–30). This means that GDP would grow approximately 3.5 times the amount of government revenues over the same period.
- The model also estimated that 166,500 sustained jobs could be added to the domestic economy in the period 2015–30. These added jobs point to a steady decrease in the unemployment rate to a value close to the natural rate of employment. These jobs would mainly be in the agriculture, energy-intensive industries, construction, and market services sectors.
- The magnitude and sustainability of these benefits will depend on many factors, including the uses of the oil and gas revenues by the government (for example, investment in infrastructure or in education, boost of household consumption, debt reduction), the type of industrial policies implemented (innovation, productivity), and the projection of the global price level of oil and gas (exogenous).
- According to the model estimates, policies focused on expanding the physical infrastructure seem to be the most effective in the medium term. Policies focused on expanding human capital seem to be the most effective in the longer term. The positive effects are multiplied when government policies are oriented to increasing total factor productivity and when the general level of oil and gas prices increases.

- A reliable gas supply to the power system providing stable power supply will improve industrial efficiency and reduce production costs and is a prerequisite for attracting foreign direct investment.
- Achieving maximum potential benefits from the new gas supply in the country is subject to the timely construction of gas-fired power plants.
- The construction phase of the oil and gas fields and policies that stimulate consumption seem to help GDP growth only in the short run. Investments in infrastructure and human capital seem to help the domestic economy and exports in the medium to the long run.

*Potential Effects on the Upstream Oil and Gas Value Chain*

- The discovery of oil and gas created high expectations for a significant positive impact on Ghanaian small and medium enterprises (SMEs) and people. The local value chain is still in the process of developing and refocusing from a traditional import-oriented business model. The government of Ghana chose the local content regulation as a mechanism to incentivize the international oil companies (IOCs) to integrate local suppliers and staff into the upstream value chains. It also created several governmental entities to control the implementation of this regulation.
- According to the value chain analysis, the development of the oil and gas fields has had limited positive effects on the local value chains in terms of employment, skills, and SME development.
- As most of the development of the Jubilee and TEN fields was completed before the local content regulation was enforced in 2014, the integration of the local value chain in that period was mainly driven by market forces. The capacity built by staff and SMEs in that period helped them to be better positioned to later serve a more regulated local content market.
- Local participation in the upstream segment has increased over time but is still considered moderate, owing to significant skills gaps in the local workforce. The situation is improving in terms of skills because of training and education programs, with an increasingly higher proportion of management and skilled technical positions initially reserved only for expatriates now being filled by Ghanaians.
- The number of different specialties demanded by the upstream oil and gas industry that can be found locally was close to 30 percent of the specialties needed in 2010, while in 2016 it had reached 46 percent, indicating a positive trend in skills development.
- Local suppliers have increased their participation in the sector over time both in terms of volume (number and value of contracts) and the type of services they offer, although the proportion of value added that stays within Ghana cannot be determined with certainty.
- Entrepreneurial programs have helped to expand access to the industry through enhancing local businesses' knowledge of quality and health, safety, and environmental standards; providing networking opportunities; and rendering those that have undertaken training more "trustworthy" in the eyes of IOCs and service companies.
- There are significant constraints to increasing local suppliers' participation in the industry. Notable among these are access to finance, access to information, and achieving technical and quality skills required by the industry.
- Ultimately, the sustainability of Ghana's efforts to support the development of the local oil and gas value chain is constrained by the small size of the sector, the increased cost to IOCs of certain local goods and services, and the corruption risks associated with the local content regulation.

**Recommendations for Ghana and the Development Community**

Given the oil and gas windfall, the study findings highlight that the government of Ghana and the development community should support policies that prioritize the upgrading of the energy system (for example, reduced transmission and distribution losses and increased gas use in power plants)

as well as significant investments in physical infrastructure in general. For example, the government should focus on utilizing the natural gas locally for electricity production to create socioeconomic value by increasing the security and reliability of electricity supply, reducing imports of diesel generators, and ensuring electricity access to all households by 2030.[2]

Industrial policies should focus on activities and components for which local technical expertise is available and transferable to other parts of the value chain, other sectors, and other industries. Such policies are necessary to create a growing and sustainable oil and gas sector, especially given the small size of the sector domestically. These policies should be complemented with policies that promote innovation and the development of human capital as a vehicle to infuse increased productivity and competitiveness in the economy. Additionally, the more the country and the development community do to improve data availability around the developmental effects of the oil and gas sector in SMEs and local jobs, the higher the chances to effectively inform these types of policies moving forward.

As further regional integration (for example, via the Economic Community of West African States) of the oil and gas markets may enhance the developmental potential for SME and job growth, there seems to be room for the development community to support this enhanced integration with knowledge products and experiences from other regions.

**Potential Follow-up Research**

Based on the findings of this study, further research can be helpful for policy development in the areas of local content, enterprise development, and industrialization.

- An assessment of how local content policies create a sustainable environment for the sector to grow is something to be further investigated. Given the recent implementation of the local content regulation, an evaluation of the impact of the regulation in two to three years could be helpful to inform policy changes. This evaluation may be enriched by benchmarking its results with the experience from other countries.
- It would be helpful to undertake an assessment of how enterprise-development programs helped to develop local companies with potential for integration in international value chains, benchmarked with the experience in comparable countries.
- Diagnostic-type studies would be helpful to identify subsectors with high value added and export potential and to determine they could be supported with policy reform and investment.[3]

**Selected quotes from stakeholder feedback during face to face interviews**

"The industry has been very new and didn't have the opportunity to develop the necessary skills yet. As a result, there have been skills gaps across the chain and different areas. However, the picture is gradually changing and some skills in the construction and operations can be sourced locally."

Ghana National Gas Company

"The main issue is with the high skills job that require years of experience on the ground."

Petroleum Commission

"Before 2013 and the introduction of the LCR everything, even food, was imported by the IOCs. Additionally, foreign companies would open subsidiaries without any Ghanaians on the equity part of the business."

Amaja Oilfield Ltd.

"There are challenges for IOCs in terms of how the LCR is implemented."

Kosmos Energy

"A significant number of registered SMEs were not active. Many initially thought that it was an opportunity for business but after the procurement requirements were available, many SMEs realized that they could not tender."

Ghana National Petroleum Corporation

"There has been an evident progress in terms of local sourcing evolution given that TEN (which started in 2015) involved a much greater number of local companies for goods and services as well as local expertise that Jubilee. In other words, in this six-to-seven-year period sectoral expertise was developed and local companies raised their standards."

Tullow Oil Ghana

"When you see that statistics of the local companies and the number of contracts given to them, the numbers look impressive. However, it is difficult to disentangle what part of the contract value stays in the country and what is essentially leaving abroad as imports. We will start a program of audits to ascertain what is the actual local part in these contracts. There are cases where only 10% of the contact essentially stays in the country."

Petroleum Commission

"As a sign of growth, some SMEs expanded their service lines by setting up subsidiaries offering additional services needed by the oil and gas sectors."

SCD

**Notes**

[1] The development of the oil and gas fields impacts the local economy through direct channels, such as the construction of the oil and gas platforms and higher use of gas in power generation, and through indirect channels, by increasing public revenues and upgrading domestic infrastructure.

[2] Our analysis showed significant economic benefits in case of energy system restructuring with increasing electrification in households, replacement of diesel generators with electricity, and domestic use of natural gas in electricity production and industries. This leads to (i) lower electricity prices due to the replacement of expensive light crude oil, (ii) reduction of Ghana's energy import dependence, (iii) improvement of power system reliability, and (iv) secondary impacts triggered from the construction of gas-fired plants, involving equipment goods (largely imported), construction (largely domestic), and auxiliary services. These positive impacts can lead to an average 4.4 percent annual growth of GDP over the 2015–30 period.

[3] See also the World Bank study *Creating Markets in Ghana, Country Private Sector Diagnostic (CPSD), Pilot (September 2017, Draft)* where the suggested WB Group actions start from the legal and regulatory framework and assess how this could become more conducive to business support for "promising" SMEs, focusing on aspects of financing and technical support adapted to the sector in which they operate.

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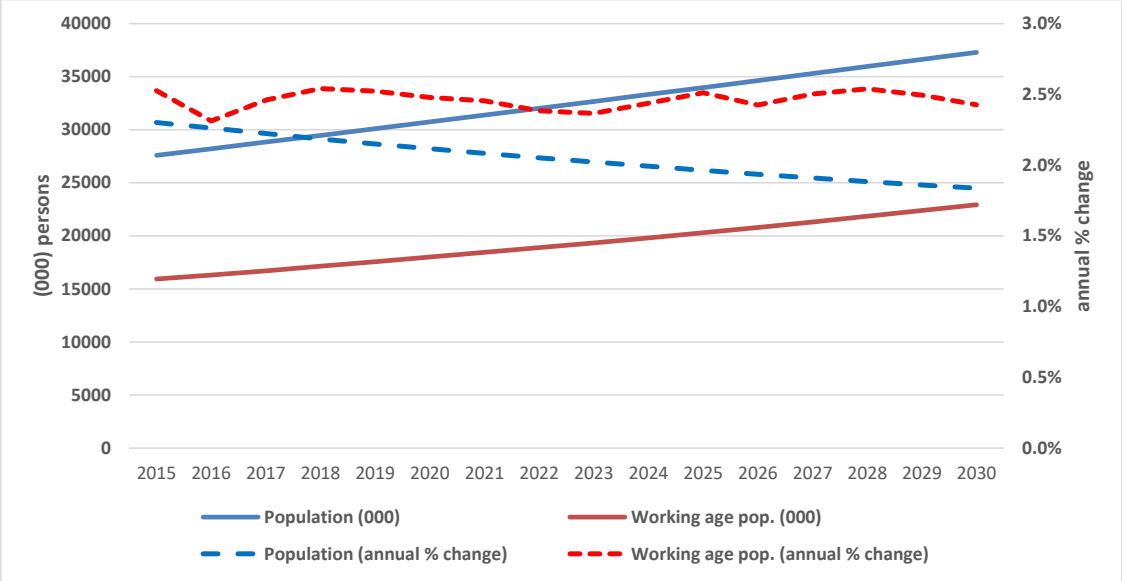
# APPENDIX A: GHANA DEMOGRAPHICS

### Population and Labor Market

Ghana's fertility rate is currently 3.94 children born to every woman in rural areas and 2.78 to every woman in urban areas. Ghana's population is currently growing at a rate of 2 percent per year. Until 2030, it is assumed there will be a gradual convergence in key demographic drivers: fertility rates will fall to 2.5 in 2030 and life expectancy will increase by three years by 2030. By the same year, the population of Ghana will reach 37 million persons.

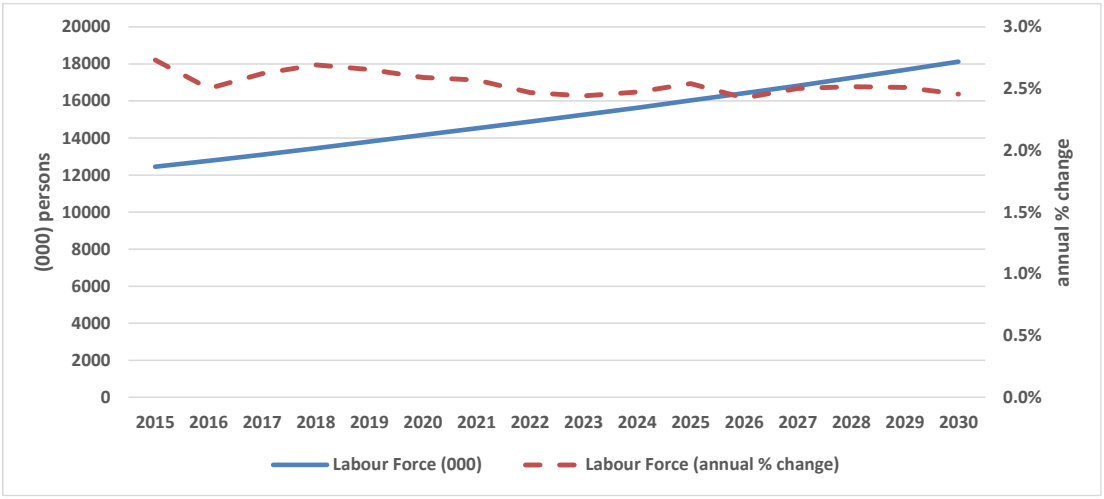
**Figure A.1: Population Projections**




*Source:* United Nations World population prospects, 2017 revision.

The labor force of Ghana in the past 20 years is gradually moving from the agricultural sector to industrial manufacturing and trade services. It is projected to increase in the period 2016–2030 following population trends and increasing participation rates.

**Figure A.2: Labor Force of Ghana**




*Source:* United Nations World population prospects, 2017 revision.

# APPENDIX B: THE POWER SECTOR

Total gas consumption in the country in 2015 was 46,911,854 million British thermal units (MMBtu), almost double than in 2014, with 56 percent coming from Nigeria via the West African Gas Pipeline (WAGP) and the rest coming from the Atuabo gas-processing plant. In 2015, the average delivery price of the WAGP imported gas was US$8.75 MMBtu and of Atuabo gas was US$8.84 MMBtu. The total cost of gas required for 2015 was about US$412 million; the estimation is based on the average gas delivery price and gas quantities supplied by the WAGP pipeline and the Atuabo plant. The energy commission of Ghana estimates that total gas cost would increase to US$489 million in 2016 due to increased supply from the Atuabo plant[1]

**Hydrocarbon Fields**

The near-term production of gas from the most developed technical resources and reserves are concentrated in three large offshore gas fields: the Jubilee field with associated gas reserves estimated at 490 billion cubic feet (bcf); the TEN fields with associated gas reserve of 363 bcf; and the Sankofa field with non-associated gas reserves of 1,107 bcf.[2]

The oil and gas discoveries in the Jubilee, TEN, and Sankofa fields are expected to support both domestic demand for fuels and power generation and foreign demand through exports. Based on 2012 and 2013 reports by the Extractive Industries Transparency Initiative for the oil, gas, and mining sectors, the contribution of oil and gas extraction to the government amounts to US$1.3 billion (6 percent of total government revenue, according to International Monetary Fund statistics (IMF Country Report No. 17/262). Revenue from the oil and gas sector alone reached US $846 million in 2013 but dropped to US $220 in 2016 as a result of a damaged turret in the Jubilee oil field and the drop of oil prices. A significant part of the revenues relates to corporate income tax from oil companies since oil production began in 2010. This tax generated some US $217 million (25 percent of total) in 2013.

The development of the Jubilee field has the potential to bring substantial benefits to the economy of Ghana, as oil resources of the field amount to 3 billion barrels of oil and the production is estimated to exceed 40 million barrels per year. The large oil production prospect of Jubilee can translate into high export revenues and increased public revenues that would benefit the Ghanaian economy. The project cost for Jubilee phase I development is estimated at about US$3.2 billion, with drilling and completion accounting for 47 percent of total cost (table B.1).

**Table B.1: Project Cost for Jubilee Phase I Development**

| Project cost | US$ million | % |
|---|---|---|
| **Drilling and completion** | 1,493 | 47 |
| **Subsea facilities** | 1,110 | 35 |
| **Surface facilities** | 129 | 4 |
| **Operations and start-up** | 280 | 9 |
| **Capitalized General and Administrative (G&A)** | 166 | 5 |
| **Total** | 3,178 | 100 |

The development of the TEN fields commenced in 2013 and is expected to produce an average gas supply of 63–70 million standard cubic feet per day. Tullow expects production from TEN to be about 50,000 barrels of oil per day (bopd) (net of 23,600 bopd) in 2017, although work continues to consider ways to increase production in the future

The Sankofa gas project, which is being developed by the Italian firm Eni, Dutch oil trader Vitol, and the Ghana National Petroleum Corporation (GNPC), involves the development of the deep-water Sankofa Main, Sankofa East, Gye Nyame, Sankofa East Cenomanian, and Sankofa East Campanian fields on the Offshore Cape Three Points block. Located 63 kilometers off the Ghanaian coast, they contain both oil and an estimated 1.45 trillion cubic feet of nonassociated natural gas. Commercial production of the field is expected in 2017 and first gas in early 2018.

**Revenues from Oil and Gas Extraction and Public Budget**

According to the fiscal regime of the petroleum agreements, the government of Ghana is entitled to a royalty on gross production of 5 percent for the Jubilee and TEN fields. The agreements also grant Ghana carried and participating interests of approximately 13.64 percent and 15.00 percent in the Jubilee and TEN fields, respectively. The corporate income tax on upstream and midstream petroleum companies for 2016 was 35 percent. According to the minister for finance, the total petroleum receipts for 2016 recorded US$247.175 million as compared to the 2016 budget estimate of US$348.42 million, leaving a variance of US$101.241 million. The total annual budget funding amount (ABFA) receipts in 2016 amounted to ₡388.85 million, with actual utilization amounting to ₡311.12 million, leaving an unutilized balance of ¢77.73 million in the Petroleum Holding Fund.

In 2016, GNPC lifted shipments from six parcels of crude oil (numbers 31 to 35 Jubilee and number 1 TEN on behalf of the state) and sold a total of 21,580 million standard cubic feet per day of gas to GNGC. Total crude oil lifted was 5,856,921 barrels of oil (4,860,462 barrels of Jubilee oil and 996,459 barrels of TEN oil), compared to 5,730,090 barrels in 2015. Total petroleum receipts (proceeds from Jubilee liftings and other petroleum receipts) as at end of 2016 was US$247.18 million. This is significantly lower than the 2015 receipts of US$396.17 million, as oil-export revenues depend greatly on the development of global oil prices; the latter have collapsed in recent years, causing unexpected budgetary deficits in the Ghanaian economy.

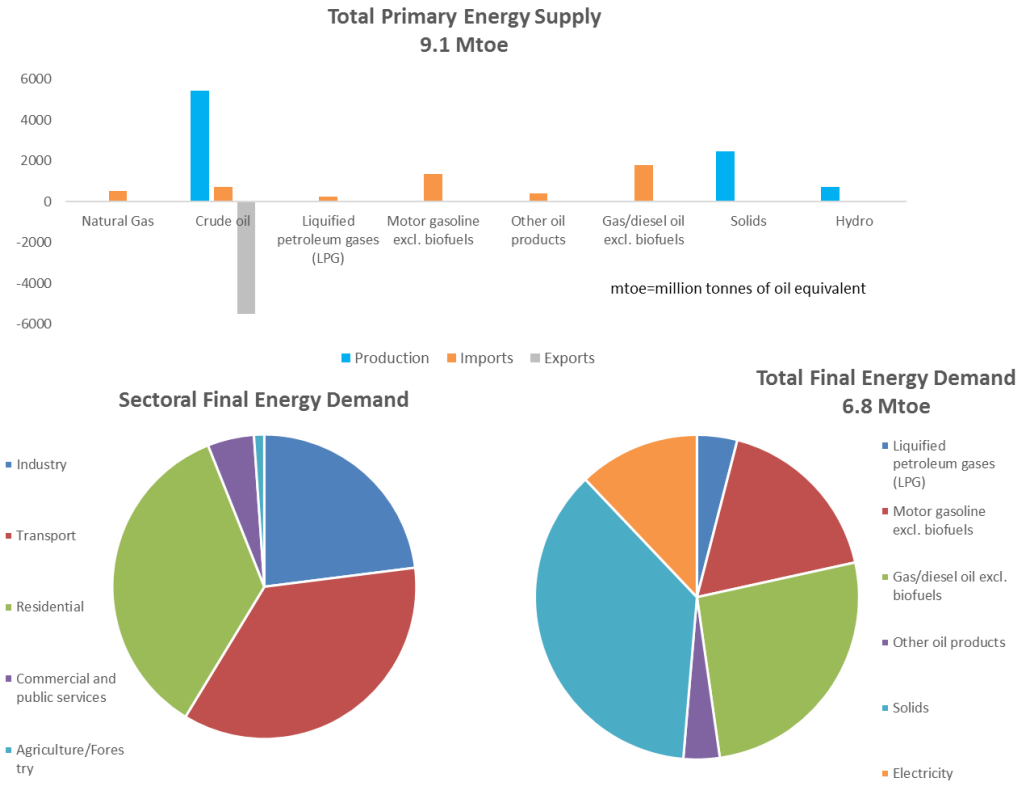
Transparency in revenue management remains one of the key policy objectives for the oil and gas sector. For the first half of 2016, a total revenue of US$126.4 million was earned, from which US$22.7 million was allocated to the Ghana National Petroleum Corporation (18 percent), US$13.5 million to Ghana Stabilization Fund (11 percent), US$64.4 million to annual budget funding amount (51 percent), and US$5.8 million to Ghana Heritage Fund (4.6 percent). ABFA funding is the percentage of petroleum revenues allocated to national budgets to support development financing, specifically financing of infrastructural projects within the oil and gas sector.

Another important policy objective is building capacity for the Ghanaians to participate in all segments of the oil and gas industry. This was established in the 2013 petroleum (local content and local participation) regulations (LI2204). This regulation requires a contractor, subcontractor, licensee, the corporation, or other allied entity carrying out a petroleum activity to ensure that "local content is a component of the petroleum activities engaged in."[3] Ghanaians employed in the sector are occupied in management, technical and in other positions in the hydrocarbon industry.

**Energy Demand**

In 2014, the total final energy consumption in Ghana was 6,783 kilotonne of oil equivalent (ktoe). Transport and residential demand accounted for almost 70 percent of total energy consumption. The major part of residential energy demand relates to solid fuels (charcoal), while electricity is also used. Transport energy demand is largely covered by petroleum products, mainly diesel oil and motor gasoline. Figure B.1 presents an overview of primary and final energy demand in Ghana.

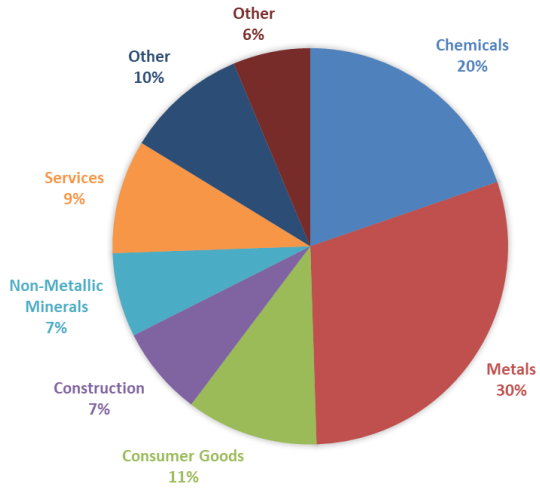
**Figure B.1: Total Final Energy Consumption in Ghana, 2014**




*Source:* IEA World Statistics Database, 2017.

Regarding industries, the chemicals and metals industries are the main energy consumers accounting for about 50 percent of total industrial energy demand (figure B.2). Other important energy consumers are cement industries (nonmetallic minerals), consumer foods and construction.

**Figure B.2: Final Energy Consumption by Industry, 2014**



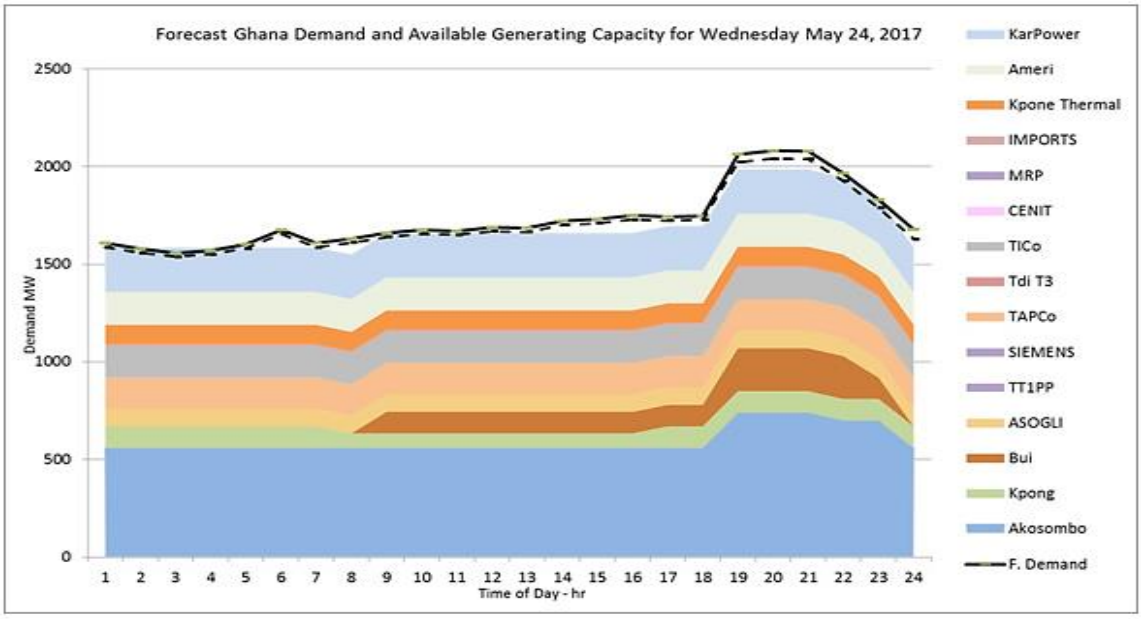

*Source:* IEA, Energy Balance 2014.

Electricity demand varies within the year and during the day, with intraday demand patterns affected by the consumption patterns of residential, commercial, and industrial customers (figure B.3). Over the last decade, Ghana has seen a steep increase in electricity demand, from 1,258 megawatts (MW) in 2,000 to 2,100 MW in 2017.

This increase has been due to three main factors:

1. High economic growth
2. Rapid urbanization
3. Increased power demand of VALCO,[4] the biggest consumer in the Ghanaian system. The operations of VALCO have been interrupted several times over the past decade due to power availability issues.

**Figure B.3: Ghana Load Curve, 2017**




*Source:* GRIDCo, http://www.gridcogh.com/en/daily-peak-demand.php.

**Security of the Energy Supply**

Ghana experienced power outages in 1983–84, 1998, and 2006–7. The country had been heavily reliant on hydropower capacities, but climate change impacts led to poor rainfall, and hydro-based generation was limited, causing frequent blackouts. Disruptions to the supply of gas from Nigeria have also worsened the security of the energy supply.

The Ghanaian power sector is estimated to require an additional US$4 billion investment to upgrade power system assets.[5] Issues affecting both electricity demand and supply side include the following:

- Demand outstripping electricity supply
- Poor condition of the transmission system because of outdated equipment
- Distribution companies' failure to pay transmission and generation companies due to the regulated tariff system and high consumer delinquency

Ensuring the security of the energy supply is a key political priority, and several measures aiming to lower energy and electricity demand and securing higher reserve capacity are being investigated.

### Energy Plans

According to the Ghana National Commission for UNESCO (Eshun and Amoakko-Tuffour 2016, 5), about $9 billion is required between 2014 and 2019 to develop the energy sector and finance its numerous initiatives, including oil and gas (which alone require $5.5 billion). There is potential for private investment in the energy sector in the form of independent power producers and under the feed-in-tariff scheme for renewable energy projects. The government of Ghana target of 5,000 MW by 2015/16, coupled with the estimated requirement of an additional 4,000 MW of capacity over the next 20 years, will require significant foreign investment, private capital, and technical expertise. The Energy Commission (EC) of Ghana has identified three energy supply options (scenarios) for medium term implementation. These options are summarized in table B.2.

**Table B.2: Energy Expansion Scenarios**

| | |
|---|---|
| **Scenario 1** | **Expansion based on natural gas to 10 percent renewable energy resources (RES) by 2020**<br>• **Convert the 125 MW Effasu barge into a combined cycle gas turbine plant, which could increase its current capacity to 187 MW.**<br>• **Expand the 330 MW Tema gas thermal station to about 660 MW by the year 2020** |
| **Scenario 2** | Expansion based on natural gas and hydro to 10 percent RES by 2020<br>• Offset the high transmission losses<br>• Construct Hydropower with a capacity of 400 MW |
| **Scenario 3** | Expansion based on natural gas and nuclear to 10 percent RES by 2020<br>• Construct a 335 MW nuclear light water reactor (IRIS-335) plant by 2018 |

The power-generation expansion programs (Bui, Tema Thermal Plant 1 and 2, Mine Reserve Plant, Asogli, and Kpone Thermal Plant), which were commenced in 2007 following the 2007 energy crisis, were expected to add about 1100 MW of generation capacity, although so far only 375 MW has been added.

The discovery of domestic oil and gas fields means that Ghana can produce electricity locally and save about $350 million annually (if production even meets a third of the country's power needs), given fluctuating crude oil prices.

The energy sector is faced with a $2.4 billion debt as the cost of buying fuel, reimbursement of energy suppliers, and inefficient state-owned companies have worsened the financial situation of the energy sector. The 2017 budget included ambitious plans to invest in renewable energy to meet 2–3 percent of electricity supply and develop decentralized solar-powered homes and businesses in remote communities. Start-up costs are estimated at about US$1,500 (Kelly 2017).

The US government and other partners (e.g. World Bank) are assisting the Ghanaian government in a slow reform of the energy and electricity market by promoting the following (based on USAID, Power Africa 2015 report):

- Transparent approach to generation expansion, including competitive bidding
- Transparent framework for the development and management of Ghana's natural oil and gas resources
- Effective allocation and pricing of hydropower
- Resource and resiliency planning among the generation, transmission, and distribution sectors
- Energy efficiency and demand-side management
- Expansion of renewable energy resources in power generation and in other sectors.

The private sector is interested in investing in new power-generation assets. However, the high market uncertainty and the unstable policy framework limit the interest of the private sector, as weak cash flows impact the Electricity Company of Ghana's operations and its ability to compensate power producers.

**Plans for Power Mix in Ghana**

Nuclear power generation has been considered in Ghana (Ennison and Djobo 2009). The Ghana Atomic Energy Commission was established in 1963 to start the Kwabenya Nuclear Reactor Project. However, the nuclear program has not progressed as expected, due to various socioeconomic and political factors. During the 2007 energy crisis, the Ghanaian government considered nuclear power a solution to power supply disruptions and formed a committee to develop a prefeasibility study and a roadmap on the development of a nuclear power plant in Ghana. However, funding is a major challenge for the capital-intensive Ghanaian nuclear program, exacerbated by the fact that most of nuclear plant components must be imported due to the country's low level of industrialization. Even if the Ghanaian nuclear program is revitalized, experience from the past shows that the process of planning, tendering, licensing, and construction may take even more than the remaining years until projection horizon (2030). Thus, nuclear power is not considered as part of Ghana's power supply mix in the Reference Scenario.

Ghana has no coal reserves and recoverable resources;[6] the construction of a coal power plant to cover base load requires high volumes of coal that must be imported, which raises energy security issues. Additional capital-intensive investment in infrastructure is required to facilitate coal imports, namely, the construction of a mini-harbor or extensive expansion and upgrading of existing port facilities in the country. Therefore, based on economic and financial considerations and energy security issues, the Reference Scenario does not include the construction of a coal power plant in Ghana.

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## Notes

[1] Energy Commission of Ghana. 2016. *2016 Energy (Supply and Demand) Outlook for Ghana*. Accra. http://www.energycom.gov.gh/files/Energy%20Commission%20-%202016Energy%20Outlook%20for%20Ghana_final.pdf.

[2] Ghana Ministry of Energy. 2016. Gas Master Plan, Accra. Available at: http://www.energymin.gov.gh/sites/default/files/06-14%20GMP%20Updated.pdf

[3] See appendix I.

[4] Aluminium-producing company in Ghana.

[5] Ghana Ministry of Energy. 2012. *Investment Opportunities in the Power Sector*. Accra. Available at: http://www.energynet.co.uk/webfm_send/2784

[6] Based on US Department of Energy classification, coal recoverable resources include only the coal that can be mined with today's mining technology after considering accessibility constraints and recovery factors.

# APPENDIX C: OVERVIEW OF THE CGE MODEL

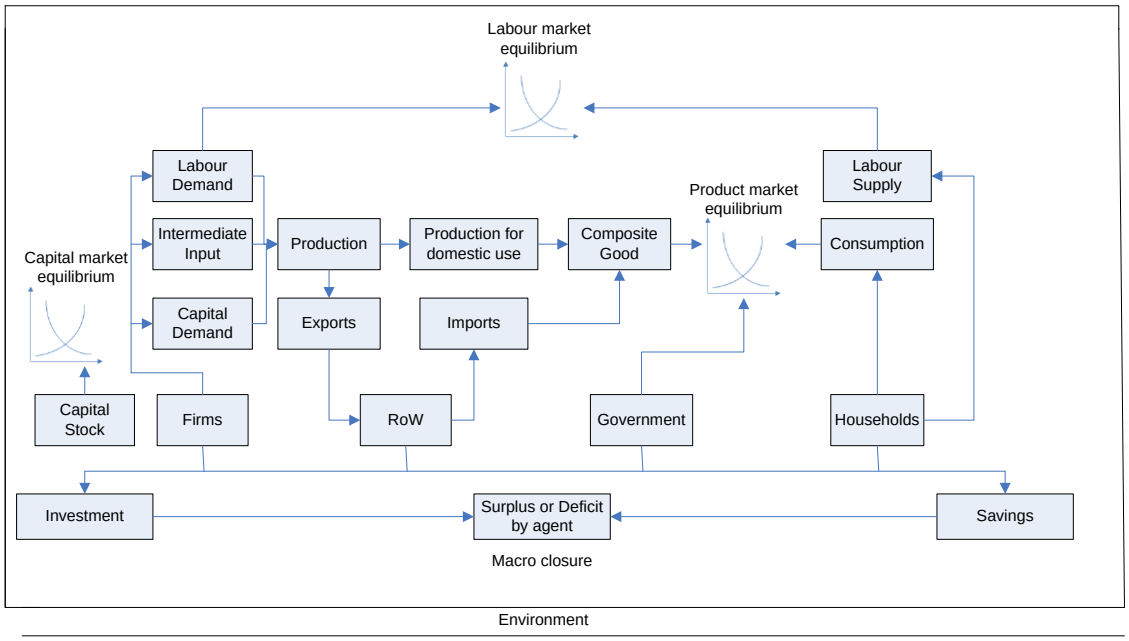
To capture the multitude of adjustments of the economic system of Ghana triggered by the increasing share of gas in the power supply we have used a detailed and advanced energy-rich computable general equilibrium (CGE) model, named GEM-E3-G. The GEM-E3-G model is based on the GEM-E3 model (Capros et al. 2013). This section provides a summary of the key model mechanisms. The description is based on the GEM-E3 model manual.

The GEM-E3 model captures the interactions of all agents, markets, countries, and sectors and computes the price vector that clears all markets simultaneously (figure C.1). Final demand by households is formulated using a complex multilevel Linear Expenditure System (LES) function which determines labor supply, savings and consumption by purpose and then by product with stock-flow relationships for durables and nondurables consumption. Total demand (final and intermediate) in each country is optimally allocated between domestic and imported goods, under the hypothesis that these are considered as imperfect substitutes (the Armington assumption); bilateral trade is fully endogenous, and possible tariff and nontariff barriers to trade are included. Institutional sectors are involved in income distribution, social benefits, fiscal payments, and revenues leading to endogenously calculated surplus or deficit by sector, including public finance, and possible constraints for balancing and debt. Various capital and labor mobility assumptions can be optionally implemented and investment and saving balancing can be obtained optionally at various regional and time-depending levels. Market clearing assumptions and perfect versus imperfect competition can also vary through the model options. The coding supports user-defining several alternative regimes and closure rules without having to re-specify or recalibrate the model.

The most important of these options are:

1. Capital mobility across sectors and/or countries
2. Flexible or fixed current account (with respect to the foreign sector)
3. Flexible or fixed labor supply
4. Market for pollution permits national/international, environmental constraints
5. Fixed or flexible public deficit

**Figure C.1: Economic Circuit of the GEM-E3 Model**




The model is designed to simulate economic development by sector, influenced by investment in infrastructure and human capital, governance developments and risk perception, population changes, and trade liberalization, among other factors. All major aspects of public finance, including all substantial taxes, social policy subsidies, public expenditures, and deficit financing, are covered. The model allows one to simulate the different complex economic, trade, energy, migration, transport, environment, and public policies up to 2050. All countries and sectors in the model are linked via endogenous bilateral trade transactions, hence capturing economic impacts triggered by changes in the competitiveness of a sector.

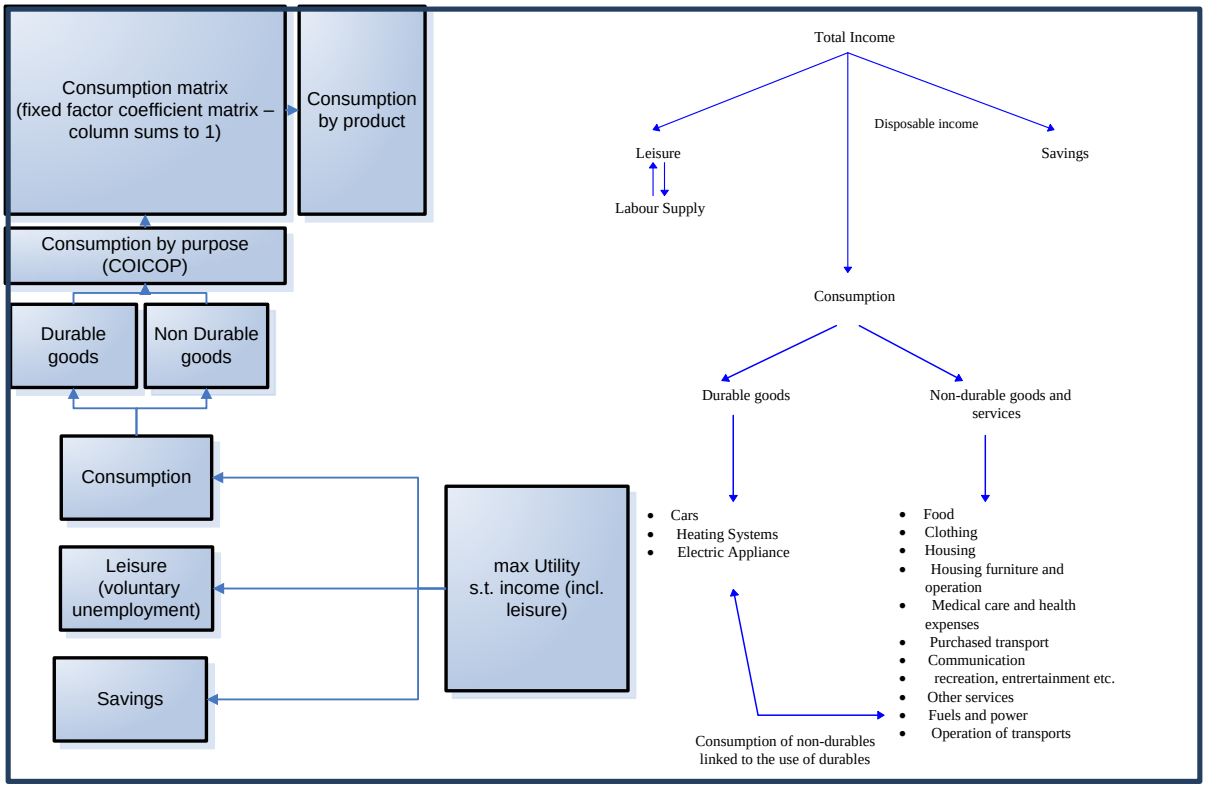
**Firms' Behavior**

Each producer (represented by an activity) is assumed to maximize profits, defined as the difference between the revenue earned and the cost of factors and intermediate inputs. Profits are maximized subject to its production technology. Domestic production is defined by branch. It is assumed that each branch produces a single good that is differentiated from any other good in the economy. Production functions in GEM-E3 exhibit a nested separability scheme, involving capital (K), labor (L), energy (E), and materials (M) and are based on a Constant elasticity of substitution (CES) neoclassical type of production function. The exact nesting scheme of production in GEM-E3 has been selected to match available econometric data on KLEM substitution elasticities and the specific features of each activity. The optimal production behavior can be represented in the primal or the dual formulation.

**Household Behavior**

Households receive income from their ownership of production factors, from other institutions, and from transfers from the rest of the world. Household expenditure is allocated among consumption, tax payment, and savings. The representative household first decides on the allocation of its income between present and future consumption of goods and leisure. At a second stage, the household allocates its total consumption expenditure among the different consumption categories available. The consumption categories are split between nondurable consumption categories (food, culture, and so forth) and services from durable goods (cars, heating systems, and electric appliances). The general form just described is depicted with a nesting scheme in figure C.2.

**Figure C.2: Consumption Structure of the GEM-E3 Model**




## The Electricity Sector

In the electricity sector a bottom-up approach is adopted for the representation of the different power producing technologies; it is based on the Managed Co-Lending Portfolio Program using endogenous estimation of a simplified load curve and solves Kuhn Tucker conditions to perform optimal capacity expansion and plant dispatching by taking into account the technical constraints of plant categories, including for variable renewables, hydro with reservoir, storage, and different ramping possibilities of thermal and nuclear plants. New technologies with learning features are included, and a projected structure of power generation in the power submodel is integrated as Leontief coefficients in the production function of the generation sector. Transmission and distribution of electricity is modelled as physical monopoly under regulated tariffs. Fossil fuel production is modelled through a specific depletable resource formulation embedded in the production functions of the corresponding sectors, allowing for pricing with endogenous mark-up. Gas supply, refineries, and other similar activities are modelled in a simple way through CES functions applying regulated tariffs for infrastructure.

Energy demand in industry and services is derived from the CES production functions. Energy efficiency possibilities are represented as cost-potential nonlinear functions with decreasing return to scale. Policy instruments are modelled to mirror energy efficiency policies and obligations. Energy demand in the household sector is derived from the complex consumption functions that distinguish between durables and nondurables. Durables are the houses, electric appliances, heating systems, and private cars. The model includes cost-potential nonlinear curves to handle energy efficiency (for example, insulation) investment and mirror policies and obligations on energy efficiency and categories of durable goods with different costs but also different energy performances. Similarly, for cars, car technologies including electric cars are represented among the possible choices. Energy consumption is derived as nondurable demand

associated to durable goods; it depends on durable good performance characteristics and on rational use of the durable good.

The GEM-E3-G model includes a bottom-up representation of the power-generation sector. The bottom-up representation of the electricity sector requires data on generation costs, technology market shares, and share of transmission and distribution cost to total cost of electricity production. These are available from the TECHPOL database, the ENERDATA database, and the PRIMES model database. The technologies incorporated in the GEM-E3-G model are presented table C.1.

**Table C.1: Electricity-Producing Technologies Represented in GEM-E3-G Model**

| | Description | No. | Description |
|---|---|---|---|
| **1** | Coal fired | **6** | Hydroelectric |
| **2** | Gas fired | **7** | Wind |
| **3** | Oil fired | **8** | CSP and photovoltaics |
| **4** | Nuclear | **9** | Coal CCS |
| **5** | Biomass | **10** | Gas CCS |

*Note:* CSP = Concentrated Solar Power; CCS =Carbon Capture Storage.

Electricity-producing technologies are characterized by different cost structures and conversion efficiencies. The projections about capital, labor, and fuel costs are substantially important, since they influence the degree of use of each technology in power generation.

Generation costs are conceived in three categories:

1. Investment costs
2. Operating and maintenance costs
3. Fuel costs

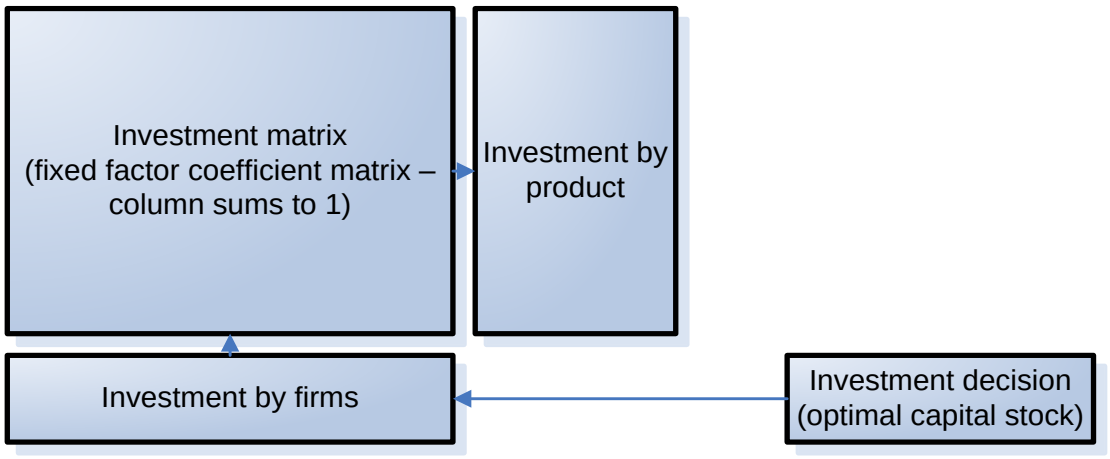
Unit-cost data and projections to the future for the first two categories were extracted from the TECHPOL and PRIMES database. The fuel costs depend on other variables of the GEM-E3. The shares of each technology in power generation in the base year are introduced from energy balance statistics. Some of the potential technologies that may develop in the future are not used in the base year. Since the production function for power generation is calibrated to the base year, it is necessary to introduce artificially small shares even for the nonexistent technologies to allow for the possibility of their penetration in the future under market conditions.

## Investment Demand

The model is dynamic, recursive over time, driven by accumulation of capital and equipment by sector through a function which can incorporate adaptive or rational expectations. Technology progress is explicitly represented in the CES multilevel production functions with fully endogenous input-output production factors, factor specific and as total factor productivity, either exogenous or semi-endogenous, depending on research and development expenditure by the private and public sectors and considering spillover effects. Moreover, knowledge capital exhibits decreasing returns to scale. The runs are performed at user-specified time intervals (usually at five-year time steps).

Figure C.3 illustrates the investment decisions of the firm in the GEM-E3 model. The basic methodological approaches to investment specification include the accelerator model and *q* of Tobin (1969).[1]

**Figure C.3: Investment Decision of Firms**




**Government Behavior**

Public investment, assumed exogenous in the model, is performed by the branch of nonmarket services. Transfers to the households are computed as an exogenous rate per head times the population.

On the receipt side, the model distinguishes between nine categories of receipts:

1. Indirect taxes
2. Environmental taxes
3. Direct taxes
4. Value added taxes
5. Production subsidies
6. Social security contributions
7. Import duties
8. Foreign transfers
9. Government firms

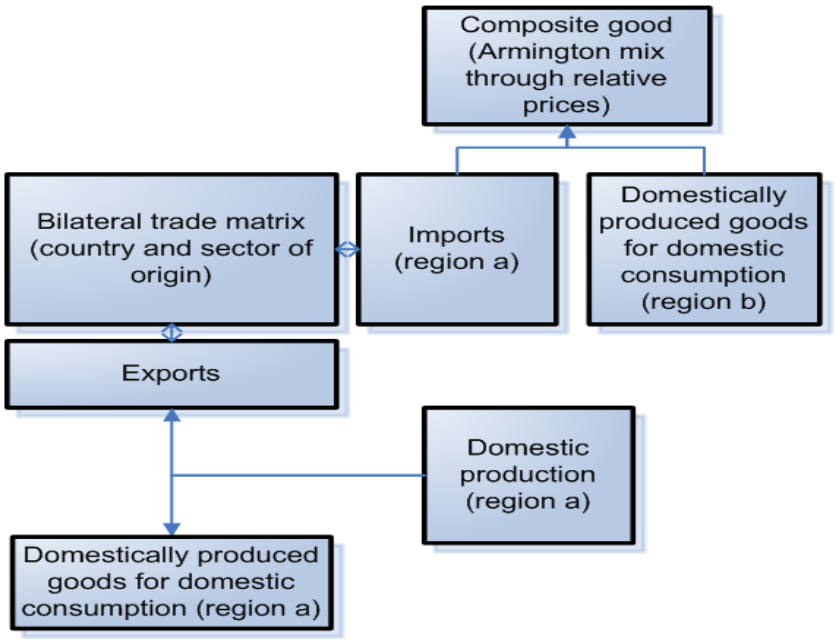
These receipts are coming from product sales (from branches) and from sectors (agents). The receipts from product sales in value, which include indirect taxes, the value added tax, subsidies, and duties, are computed from the corresponding receipts in value, given the tax base and the tax rate. The receipts from agents are computed from the tax base and the tax rate (social security contributions, direct taxation), share of government in total capital income (for government firm's income), or exogenous (transfers from and to the RW).

**Domestic Demand and Trade Flows**

The demand for products by the consumers, the producers (for intermediate consumption and investment), and the public sector constitute the total domestic demand. This total demand is allocated between domestic products and imported products, following the Armington specification.[2] In this specification, branches and sectors use a composite commodity that combines domestically produced and imported goods, which are considered as imperfect substitutes (Armington assumption).

Each country buys and imports at the prices set by the supplying countries following their export supply behavior. The buyer of the composite good (domestic) seeks to minimize his total cost and decides the mix of imported and domestic products so that the marginal rate of substitution equals the ratio of domestic-to-imported product prices.

**Figure C.4: Trade Matrix for Ghana and the Rest of the World**




GEM-E3-G employs a nested commodity aggregation hierarchy, in which branch's $i$ total demand is modelled as demand for a composite good or quantity index $Y_i$, which is defined over demand for the domestically produced variant ($XXD_i$) and the aggregate import good ($IMP_i$). At a next level, demand for imports is allocated across imported goods by country of origin. Bilateral trade flows are thus treated endogenously in GEM-E3-G.

**The Labor Market**

The GEM-E3-G model does not assume full clearing of the labor market via wage adjustments but includes involuntary unemployment via the efficiency wages mechanism. This extension consists of introducing rigidities and imperfections in the labor market, which shifts utility-derived labor supply to the left and upward.

This modelling approach is preferred because of its empirical validation—by using for example Blanchflower and Oswald (1994)—its simplicity, and the fact that it is parsimonious in parameters. The specification of efficiency wages in GEM-E3 is based on Shapiro and Stiglitz (1984) and Annabi (2003) approaches.

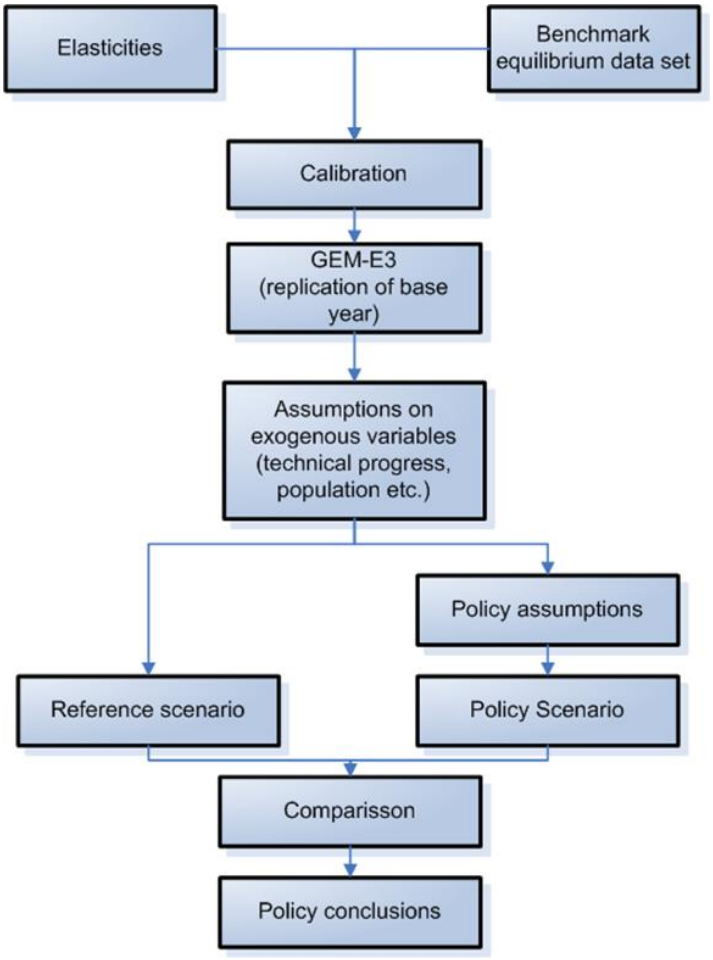
**Comparative Analysis and Output**

The model allows for a consistent comparative analysis of policy scenarios, because it ensures that in all scenarios the economic system remains in general equilibrium. In addition, it incorporates microeconomic mechanisms and institutional features within a consistent macroeconomic framework and avoids the representation of behavior in reduced form. Particularly valuable are the insights the model provides regarding the distributional aspects of long-term structural adjustments. The sequence of steps taken to perform a scenario is provided at C.5. The key outputs of the model are the following:

- Full input-output tables by country and/or region
- National accounts
- Employment by economic activity and skill
- Unemployment rate

- Balance of payments
- Public finance and revenues,
- Household Consumption, energy use, and supply
- GHG emissions and atmospheric pollutants

**Figure C.5: Steps Followed to Perform Scenario Analysis with the GEM-E3-G Model**

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## Notes

[1] According to this approach, net investment depends on the relationship between the market price of the capital good and its replacement cost.

[2] In the GEM-E3 model it is assumed that the buyer's decision is uniform throughout the economy. Therefore, the Armington specification is applied at the level of total domestic demand for each sector.

# APPENDIX D: OUTPUT AND EMPOYMENT MULTIPLIERS

## Preliminary Estimates with IO (Input-Output) Multipliers

IO multipliers are useful as summary indicators that show the degree to which an industry is connected into an economy.[1] These multipliers provide an intuition on the backward and forward links of an industry but have a series of limitations, including the lack of supply-side constraints (final demand can increase indefinitely and supply will always find the resources to meet this demand), the non-substitutability among production factors, and the fixed-prices assumption. In applied policy analysis, much more complex methodologies are used that consider the dynamics of technology options, resource limitations, and price feedback effects (for example, computable general equilibrium models). For the current study, employment and output multipliers were estimated with a 2015 input-output table to gain an understanding on the importance of firms in terms of their integration in the economic system.

The study estimated that approximately US$16 billion is invested in the development of the oil and gas fields with the following allocation: 80 percent are directed to equipment goods, 10 percent to transport, 5 percent to construction, and 5 percent to market services.[2] In Ghana, equipment goods are largely imported, as their share of domestic production is only 4 percent. Hence, the output multiplier of the sector is only 1.04, and additional demand for equipment will not trigger direct and indirect positive impacts inn the Ghanaian economy. However, construction, transport, and market services are to a large extent produced domestically. Based on the 2015 Ghana multipliers, the US$16 billion invested in the oil and gas fields would have an estimated impact on the Ghanaian production of about US$18.5 billion. If the full US$16 billion were directed to the local economy, then the overall estimated impact would be about US$22 billion (both direct and indirect).

The methodology used to compute the type I and II multipliers is standard and is described in many textbooks, hence not covered here. Table D.1 presents the type I and II output and employment multipliers of Ghana for the year 2015.

**Table D.1: Output and Employment Multipliers**

| | Agriculture | Ferrous metals | Nonferrous metals | Nonmetallic minerals | Air transport | Road: Passenger transport | Construction | Business services | Market services | Nonmarket services | Road: Freight transport | Hydro electric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output multiplier type I** | 1.5 | 1.1 | 1.1 | 2.2 | 1.5 | 1.7 | 1.3 | 1.3 | 1.8 | 1.8 | 1.6 | 1.3 |
| **Output multiplier type II** | 4.1 | 1.1 | 1.4 | 2.7 | 2.4 | 2.9 | 1.9 | 2.4 | 2.8 | 3.4 | 2.8 | 1.9 |
| **Employment multiplier** | 4.5 | 1.3 | 1.2 | 2.9 | 1.9 | 1.2 | 1.2 | 1.7 | 5.2 | 1.5 | 2.4 | 1.7 |

## Gas Industry Multipliers Derived from the GEM-E3-G Model and a Social Accounting Matrix (SAM) Approach

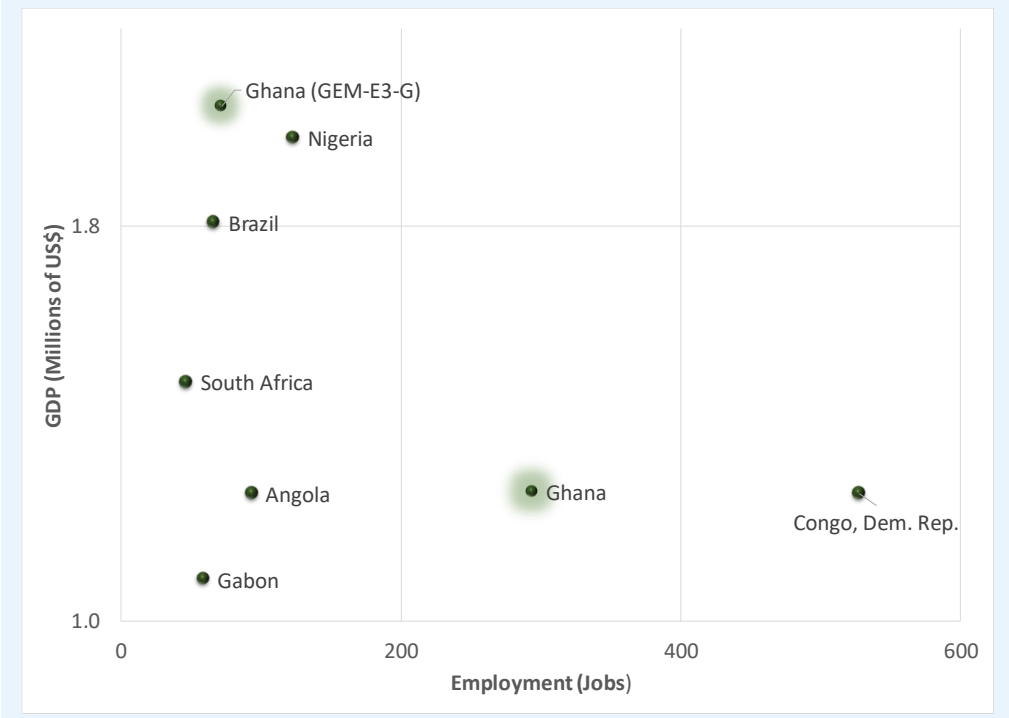
According to the GEM-E3-G model estimates for 2015–30, the multiplier effect of the development of the oil and gas sector would be much larger on GDP than on employment (figure D.1). The model takes into account that the oil revenues would be used to upgrade infrastructure and help to improve labor productivity and the competitiveness of the economy leading to higher

income. As the productivity increases, income and employment increases, but fewer labor hours are needed per unit of output.

As a reference, Figure D.1 also shows GDP and employment multipliers[3] for Ghana and other countries using a SAM-based approach.[4] The two approaches provide different multipliers. The estimates obtained from the GEM-E3-G model for Ghana have a higher economic multiplier but relatively lower employment multiplier compared to the estimates of the multipliers obtained from the IFC SAM model for Ghana. These differences are attributed to the different methodological approaches. The output multiplier provided by the GEM-E3-G model is about 2.4 compared to a 1.4 of the SAM-based approach. The main reason for this difference is that the SAM approach does not consider the use of the public revenues resulting from the operation of the oil and gas industries to improve the country's' infrastructure and hence its productivity and competitiveness.

Both approaches capture direct, indirect, and induced effects, but the SAM approach performs these calculations under a static context with regards to prices and substitution possibilities. Other strong assumptions of the SAM-based approach include the unlimited resources and supply responses in the domestic economy (infinite supply of labor skills) and the static or unchanged structure of the economy (with respect to technology availability and sectoral contribution to total value added).

**Figure D.1: Estimated Multipliers on GDP and Employment (per US$1 million of additional revenue)**




*Source:* The Ghana GEM-E3-G model for the data point "Ghana (GEM-E3-G)". For all other data points, the main database is the Global Analysis Trade Project (GTAP), version 9, West Lafayette, IN: Purdue University, https://www.gtap.agecon.purdue.edu/databases/v9/. For computing employment elasticity, employment, and GDP, data is taken from the World Bank's World Development Indicators, Washington DC: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

Using the SAM approach, and compared with Ghana, the oil and gas sector in relatively more sophisticated economies (such as Brazil, Nigeria, Egypt, South Africa) seem to produce higher impacts on GDP than on employment. However, equally or less sophisticated economies seem to produce either less employment impacts (Angola and Gabon) or more employment impacts (Democratic Republic of Congo). This may be related to the degree of success of the type of local content policies implemented in those countries.

The output multiplier for Ghana derived from the SAM-based approach is low when compared to the output multipliers of some other fossil-resource-rich countries Figure D.1. Countries such as Brazil, Nigeria, Egypt, or South Africa that more are diversified in terms of industrial production, have a longer history in oil and gas extraction and trade, and have a fossil industry more integrated into their economy (i.e. have integrated better the local value chains) are more likely to have higher output multiplier effects.

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## Notes

[1] *Output multiplier type I captures* the direct and indirect increases in output as a result of the increased demand for the product of a specific industry. If there is a demand of US$1 for the output of the industry, then an output multiplier of 1.5 shows that the output in the economy will increase by US$1.5. (US$1 is the direct increase in output delivered by the *i* industry and US$0.5 is the increase in all other industries that are connected to the *i* industry).
*Output multiplier type II* captures the direct, indirect (as type I), and induced increases in output. Induced increases in output reflect the changes in output driven by changes in household income. Hence, if an output multiplier of type I is 1.5 and of type II is 1.9 this decomposes to: $1 direct output, 0.5 indirect output, and 0.4 induced output.
*The employment multiplier* shows how many jobs are created throughout the economy as a result of one additional full-time equivalent job in one industry.

[2] Estimates based on public information made available by the companies involved (for example, Tullow 2017).

[3] These multipliers are due to an additional US$1 million increase in revenue. The GDP multiplier increases due to the additional US$1 million in the oil and gas sector. Similarly, the employment multiplier increases the number of jobs) due to the additional US$1 million. These multipliers include direct, indirect, and induced effects.

[4] The main database for this model is the Global Analysis Trade Project (GTAP), version 9, West Lafayette, IN: Purdue University, https://www.gtap.agecon.purdue.edu/databases/v9/. For computing employment elasticity, employment, and GDP, data is taken from the World Bank's World Development Indicators, Washington DC: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

# APPENDIX E: PLAYERS IN THE GHANAIAN OIL, GAS, AND POWER SECTORS

**Table E.1: Installed Power Capacity in Ghana, 2017**

| Plant | Installed capacity (MW) | Dependable capacity (MW) | Type of plant | Fuel type | Year constructed | Additional information |
|---|---|---|---|---|---|---|
| **Akosombo Hydro Plant** | 1,020 | 900 | Hydro | Water | 1965 | Ownership: Public (VRA) |
| **Kpong Hydro Plant** | 160 | 140 | Hydro | Water | 1982 | Ownership: Public (VRA) |
| **TAPCO - T1** | 330 | 300 | Thermal | LCO/Gas | | Ownership: Public |
| **TICO - T2** | 330 | 320 | Thermal | LCO/Gas | | Ownership: Public |
| **Mines Reserve Plant (MRP)** | 80 | 70 | Thermal | Gas | | Ownership: Public |
| **Tema Thermal 1 Plant (TT1P)** | 110 | 100 | Thermal | Gas/LCO | 2008 | |
| **Tema Thermal 2 Plant (TT2P)** | 49.5 | 45 | Thermal | Gas | 2008 | |
| **Tema Thermal 2 Plant Expansion (TT2PP-X)** | 38 | 32 | Thermal | Gas | | |
| **Kpone Thermal Power Plant (KTPP)** | 220 | 200 | Thermal | Gas/DFO | 2017 | IPP, US$410 construction budget: fuel gas will be supplied through a connection to the nearby WAGP |
| **VRA Navrongo Solar Plant** | 2.5 | - | Solar | Sunlight | | Ownership: Public |
| **Bui Hydro Plant** | 400 | 340 | Hydro | Water | 2013 | IPP |
| **Kar Power Barge 1** | 235 | 225 | Thermal | HFO | | IPP |
| **Sunon Asogli Phase 1** | 200 | 180 | Thermal | Gas | 2010 | IPP |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Sunon Asogli Phase 2, Stage 1** | 180 | 160 | Thermal | LCO/Gas | 2010 | IPP |
| **Sunon Asogli Phase 2, Stage 2** | 180 | 160 | Thermal | Gas/LCO | 2010 | IPP |
| **CENIT Power Plant** | 110 | 100 | Thermal | LCO | | IPP |
| **Ameri Power Plant** | 250 | 230 | Thermal | Gas | | IPP |
| **BXC Solar** | 20 | - | Solar | Sunlight | | IPP |
| **AKSA** | 360 | 340 | Thermal | HFO | | IPP |
| **Total Capacity** | 4,275 | 3,842 | | | | |

*Source:* Adapted from Volta River Authority (VRA).

*Notes:* DFO = Diesel Fuel Oil; HFO = Heavy furnace oil ; IPP = independent power producer; LCO = light cycle oil; WAGP = West African Gas Pipeline.

**Table E.2: Planned Power Generation Projects**

| Planned Projects | MW | % of total | Type | Sponsor | Estimated year online |
|---|---|---|---|---|---|
| **Mere Power Nzema (Blue Energy, UK)** | 155 | 7.1% | Solar | Private | 2015/16 |
| **Siginik Energy (Episolar, Canadian)** | 50 | 2.3% | Solar | Private | 2015 Solar |
| **Ghana 1000 (General Electric)** | 1,050 | 47.8% | Thermal | Private | 2017/18 |
| **Jacobsen/Jelco** | 360 | 16.4% | Thermal | Private | 2016 |
| **Cenpower Plant** | 348 | 15.5% | Thermal | Private | 2016 |
| **Amandi Energy** | 243 | 11.1% | Thermal | Private | 2017 |
| **Total** | **2,206** | | | | |

*Source:* Ghana Investment Brief Power Africa 2015. Available at: https://www.usaid.gov/sites/default/files/documents/1860/Ghana%20_IG_2015_05_03.pdf

The upstream hydrocarbon industry is made up of a mix of major multinational oil companies (Eni), independents (Hess, Anadarko, Tullow, Kosmos, and so forth), national oil companies (PetroSA), and local Ghanaian companies. Table E.3 lists the operators in the exploration of oil and gas, with their investments made to date.

## Table E.3: Operators in the Exploration of Oil and Gas, with Investments Made to Date

| OPERATOR | PROJECT/BLOCK/FIELD | OWNERSHIP STRUCTURE | | PHASE OF WORK | INVESTMENTS MADE FROM INCEPTION TO DECEMBER 2016 (US$) |
|---|---|---|---|---|---|
| TULLOW OIL GHANA LIMITED | Jubilee Field Project | Tullow Ghana Limited<br>Kosmos Energy Ghana<br>Anadarko Petroleum Corporation<br>Petro SA (formerly Sabre Oil)<br>GNPC Interest (carried & additional) | 35.47954%<br>24.07710%<br>24.07710%<br>2.72544%<br>13.64084% | Production | 9,902,538,249.27 |
| TULLOW OIL GHANA LIMITED | Deep Water Tano (DWT)<br>TEN Field | Tullow Ghana Limited<br>Anadarko Petroleum Corporation<br>Kosmos Energy Ghana<br>PetroSA<br>GNPC Interest (carried & additional) | 47.175%<br>17.00%<br>17.00%<br>3.825%<br>15.00% | Production | 5,821,207,913.75 |
| ENI GHANA E & P LTD | Offshore Cape Three Points Block - Sankofa Gye-Nyame (SGN) | ENI Ghana E & P Ltd<br>Vitol Upstream Ghana Ltd<br>GNPC Interest (carried & additional) | 44.444%<br>35.556%<br>20.00% | Near production | 2,382,501,508.00 |
| HESS GHANA EXPLORATION LIMITED | Deepwater Tano Cape three Points (DWTCTP) | Hess Ghana Exploration Limited<br>Lukoil<br>GNPC Explorco<br>Fuel Trade<br>GNPC Interest<br>(additional 3.00% not yet exercised) | 40.00%<br>38.00%<br>10.00%<br>10.00%<br>2.00% | Near Development | 1,775,399,208.12 |
| AGM PETROLEUM | South Deepwater Tano Block | AGM Petroleum<br>GNPC Interest<br>GNPC-Explorco<br>(additional 15.00% not yet exercised) | 66.00%<br>10.00%<br>24.00% | Exploration | 3,662,807.90 |
| ERIN ENERGY | Expanded Shallow Water Block | Erin Energy Ghana Limited<br>Base Energy<br>GNPC-Explorco<br>GNPC Carried Interest<br>(additional 10.00% not yet exercised) | 54.00%<br>13.00%<br>23.00%<br>10.00% | Exploration | 10,267,710.50 |

| OPERATOR | PROJECT/BLOCK/FIELD | OWNERSHIP STRUCTURE | | PHASE OF WORK | INVESTMENTS MADE FROM INCEPTION TO DECEMBER 2016 (US$) |
|---|---|---|---|---|---|
| COLA NATURAL RESOURCES | East Cape Three Points Block | Cola Natural Resources Ltd<br>Medea Development Ltd<br>GNPC Carried Interest<br>(additional 17.5% not yet exercised) | 54.00%<br>36.00%<br>10.00% | Exploration | 22,796,984.13 |
| AMNI PETROLEUM | Offshore Central Tano Block | AMNI International Petroleum Development Co. Ltd<br>GNPC Interest<br>(additional 20.00% not yet exercised) | 90.00%<br>10.00% | Exploration | 9,418,000.00 |
| SAHARA ENERGY | Shallow Water Cape Three Points (SWCTP) | Sahara Energy Fields<br>Sapholda<br>GNPC Interest<br>(additional 15.00% not yet exercised) | 85.00%<br>5.00%<br>10.00% | Exploration | *82,000,000.00 |
| ECO ATLANTIC | Deepwater Cape Three Point West Offshore Block | A-Z Petroleum<br>Eco Atlantic<br>GNPC Explorco<br>PetroGulf<br>GNPC Interest<br>(additional 20.00% not yet exercised) | 27.88%<br>50.42%<br>4.35%<br>4.35%<br>13.00% | Exploration | *195,000,000.00 |
| UB RESOURCES | Offshore Cape Three Points South Block | UB Resources<br>Royal Gate<br>Houston Drilling<br>GNPC Carried Interest<br>(additional 25.00% not yet exercised) | 70.47%<br>4.35%<br>12.18%<br>13.00% | Exploration | 3,148,482.81 |
| GOSCO | Offshore South West Tano Block | Heritage Exploration and Petroleum Ghana<br>Blue Star Exploration Ghana<br>GNPC - Explorco<br>GNPC Carried Interest<br>(additional 13.00% not yet exercised) | 39.60%<br>39.60%<br>8.80%<br>12.00% | Exploration | 3,263,231.00 |

| OPERATOR | PROJECT/BLOCK/FIELD | OWNERSHIP STRUCTURE | | PHASE OF WORK | INVESTMENTS MADE FROM INCEPTION TO DECEMBER 2016 (US$) |
|---|---|---|---|---|---|
| GOSCO | East Keta Block, offshore Ghana | Heritage Exploration and Petroleum Ghana<br>Blue Star Exploration Ghana<br>GNPC - Explorco<br>GNPC Carried Interest<br>(additional 9.00% not yet exercised) | 38.70%<br>38.70%<br>11.60%<br>11.00% | Exploration | 6,665,366.00 |
| BRITTANIA-U | South-west Saltpond Block Offshore | Brittania -U<br>GNPC Carried Interest<br>(additional 5.00% not yet exercised) | 80.00%<br>20.00% | Exploration | *100,000,000.00 |
| SPRINGFIELD ENERGY | West Cape Three Points Block 2 | Springfield<br>GNPC Explorco<br>GNPC | **84% Option A & 82% Option B<br>5% Option A & 10% Option B<br>11% Option A & 8% Option B | Exploration | *100,000,000.00 |
| ENI GHANA E & P LTD | Cape Three Points Block 4 | ENI Ghana E & P Ltd<br>Vitol Upstream Ghana Ltd<br>Woodfields<br>GNPC Explorco<br>GNPC | 42.4691%<br>33.9753%<br>9.5556%<br>4%<br>10% | Exploration | *125,000,000.00 |
| SWISS AFRICAN OIL COMPANY LTD | Onshore/Offshore Keta Delta Block | Swiss African Oil Company Ltd<br>PET Volta Investments Ltd<br>GNPC | 83%<br>5%<br>12% | Exploration | *100,000,000.00 |
| GHANA NATIONAL PETROLEUM CORPORATION | Voltaian Basin | GNPC | 100% | Pre-Exploration | *144,000,000.00 |

* Minimum Expenditure

** Option A - New Discoveries
Option B - Existing Discoveries

*Source:* Provided by Ghana National Petroleum Corporation.

# APPENDIX F: SECTORAL VALUE ADDED

**Table F.1 Sectoral Value Added in the Reference Scenario**

| Share to total GVA | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Agriculture | 28.1 | 23.9 | 23.3 | 23.0 |
| Energy | 1.0 | 2.9 | 5.0 | 6.8 |
| Retail trade | 6.0 | 4.6 | 3.6 | 2.9 |
| Transport | 11.2 | 9.0 | 7.9 | 7.1 |
| Mining | 0.9 | 1.0 | 1.3 | 1.5 |
| Industry | 27.3 | 30.4 | 32.4 | 33.8 |
| Services | 25.5 | 28.1 | 26.5 | 25.0 |
| Total | 100 | 100 | 100 | 100 |

*Note:* GVA =Gross Value Added

# APPENDIX G: THE JUBILEE, TEN, AND SANKOFA FIELDS

## Overview

*Relevance of Oil and Gas in Ghana*

For many years, unreliable electricity access has slowed Ghana's growth. Developing the energy infrastructure is essential to leverage the country's potential (AfDB, OECD, and UNDP 2016). The oil and gas production stems from only three fields: Jubilee, Tweneboa, Enyenra and Ntomme (TEN), and Sankofa (Map G.1). Therefore, their operation is crucial to uphold the current state (World Bank 2013), and investment in Ghana's oil and gas sector has been prioritized by the country and international financing institutions.

The government of Ghana aims to diversify and expand the power supply by extending the national oil supply (Jubilee and TEN) and gas supply (Sankofa) and thus reducing dependency on hydropower systems and gas imports (Oil Review Africa 2017; World Bank 2017). The Ministry of Energy also states that transparency and accountability will strengthen the sector. This is the focus of a larger World Bank group program that aims to develop Ghana's power sector (IFC 2017). It supports the International Finance Corporation's (IFC's) investments into the three fields with legislative reforms, off-grid service development, and process improvements. Moreover, the U.S. Millennium Compact Challenge has committed to supporting the Electricity Company of Ghana (ECG) with US$340 million of complementary grant funds (World Bank 2015b)

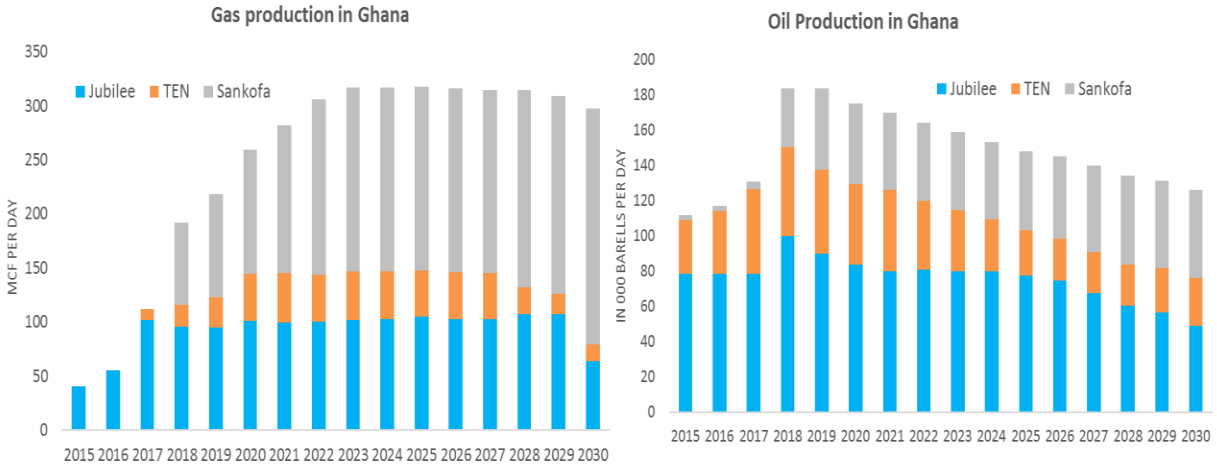
The ECG has launched prepaid metering and a firm-wide commercial management system to increase efficiency (World Bank 2015b). Apart from these structural changes, additional energy infrastructure is being developed. Gas-fired power plants amounting to 2,500 megawatts (MW) are expected to be constructed by independent power producers (IPPs), and a gas-processing and transport project has been commissioned. The latter aims at supporting the Offshore Cape Three Points (OCTP) block (which includes Sankofa) by connecting the Jubilee site with the Aboadze power complex in western Ghana. In 2015, the World Bank estimated that if all planned and committed capacity additions are executed, demand will be met by 2019 (World Bank 2015b).

**Map G.1: Ghana's Oil and Gas Environment**


*Source:* Jubilee Field Map 2009

The yearly production of oil and gas from each field is presented in figure G.1 and figure G.2.

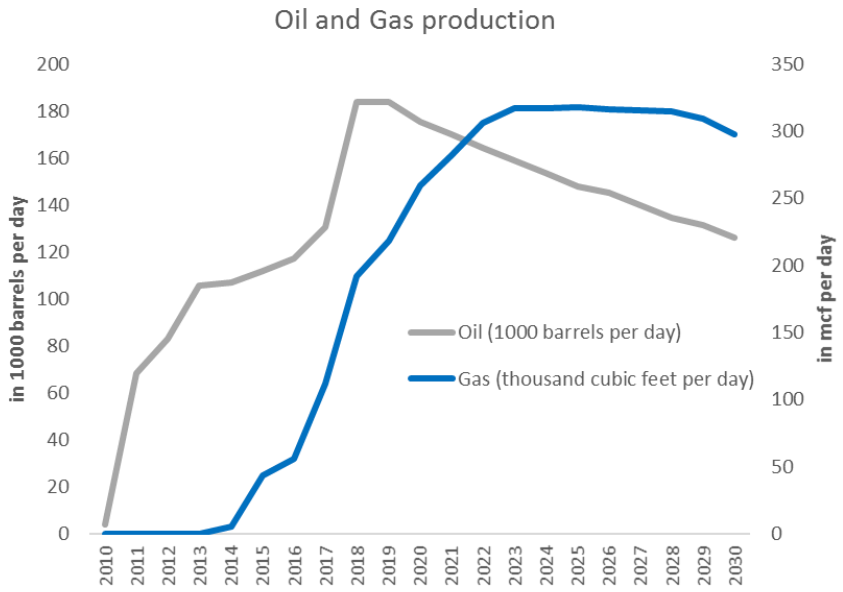
**Figure G.1: Daily Oil and Gas Production in Ghana until 2030**




*Note: MCF=Thousand Cubic Feet, Barrel=unit of volume*

*Source: E3 Modelling Analysis*

**Figure G.2: Oil and Gas Production**




*Note: MCF=Thousand Cubic Feet, Barrel=unit of volume*

*Source: E3 Modelling Analysis*

*International Finance Corporation (IFC) Contributions in Ghana*

Since joining in the 1950s, Ghana has maintained a strong relationship with the World Bank Group, becoming the third-largest receiving country in Africa. Over the years, Ghana has received about US$2.5 billion in financing for 75 projects from the IFC, of which it directly supplied US$2.1 billion and mobilized US$400 million. As of June 2016, the IFC had a committed investment volume of US$859.9 million in Ghana (of which US$474 million outstanding). For the Jubilee field, Kosmos Energy received US$200 million and Tullow Oil received US$165 million in loans. Tullow Oil received an additional US$255 million to develop the TEN field (World Bank 2015c). For the Sankofa project, the World Bank Group guaranteed US$700 million of the Ghana National Petroleum Corporation's (GNPC's) payments to private sponsors (Eni and Vitol) and the recipients of other obligations (World Bank 2015b). Moreover, the IFC invested US$235 million in Vitol to develop the gas infrastructure (IFC 2017). Beyond direct and long-term financial contributions at market rates, the IFC also mobilizes further investments and transfers knowledge, for example, through environmental consulting. See table G.1 for further IFC involvement.

**Table G.1: Overview of Private Corporations That Received IFC Investments in Ghana**

| | GNPC | Kosmos Energy | Tullow Oil | Vitol |
|---|---|---|---|---|
| Location | HQ: Tema (Accra) | HQ: Texas, US<br>Ghana: Accra | HQ: London<br>Ghana: Accra | HQ: Rotterdam, NL<br>Ghana: Accra |
| Field involvement | Jubilee, TEN, Sankofa | Jubilee, TEN | Jubilee, TEN | Sankofa |
| Value chain focus | Upstream:<br>Exploration and production | Upstream:<br>Exploration and production | Upstream:<br>Exploration and production | Midstream:<br>Trading and distribution |
| Area focus | Ghana | Atlantic Margin and Africa | South America and Africa | Worldwide on 6 continents |
| Focus of firm | Support reliable supply by developing Ghana's own petroleum resources | Underexplored land with hydrocarbon potential | Exploration, appraisal and selective development | - |
| Reserves and resources | Partner in all of Ghana's petroleum agreements | 77 mmboe (proven 2016):<br>• 74 million barrels crude oil<br>• 15 bcf natural gas | 1,194 mmboe (2016):<br>• 54% in East Africa<br>• 46% in West Africa & EU | Trading over 7 million barrels of crude oil and products per day |
| Capital structure | - | Capital program of US$800 million (2015):<br>• 65% tied into development<br>• 35% tied into exploration and appraisal | • US$1.270 million revenues (2016) from West African and European activities<br>• US$857 million CAPEX (2016) tied into West and East Africa and new ventures | US$152 bn revenues (2016). Investments in energy assets, incl.<br>• 15.9 $Mm^3$ of storage<br>• 390 thousand barrels per day (kbpd) of refining capacity |
| Listing | State-owned | New York Stock Exchange | London, Irish, and Ghana Stock Exchanges | Privately owned by holding company |
| Employees | 300 (2016) | ~270 (2016) | 1,152 (2016) | 5,441 (2014) |

*Source:* Composed using information from GNPC n.d.; Kosmos Energy (a) and (b); Tullow Oil 2017; Vitol 2017.

*Note: mmboe=million barrels of oil equivalent, bcf=billion cubic feet, Mm3=Million cubic meters*

## Jubilee Field

*Investment Background*

In 2007, two exploration wells confirmed the Jubilee Oil Field's approximate 600 million barrels of recoverable oil reserves (Tullow Oil 2017a, World Bank 2015b) and about 800 billion cubic feet of associated gas resources. The oil samples showed high-quality light crude oil with low sulphur content (World Bank 2009). The field lies about 60 kilometers off Ghana's coast, at a depth of about 1,250 meters. It lies between the license blocks Deepwater Tano and West Cape Three Points (map G.2) (World Bank 2009).

**Map G.2: Jubilee Oil Field**


*Source:* Tullow Oil 2018a

The Jubilee discovery was the decade's largest in offshore West Africa (Kosmos Energy n.d. c) and Ghana's first oil production project (IFC 2015a). It enabled a diversification of Ghana's oil and gas sector and the increase of private investment as gas resources were identified, the dependency from oil imports decreased and the possibility of long-term oil export arose (World Bank 2009). Jubilee has contributed significantly to the Ghanaian energy sector and economy (IFC n.d. b):

**Figure G.3: Jubilee's Benefits to Ghana**

**Reduction of fiscal deficits**

Additional annual government revenues of ~US$1 billion during peak production will enable government investments into infrastructure and humanitarian services which in turn enable economic growth.

**Lowering of import-export imbalance**

Ghana will no longer be a net-oil-importer and have foreign exchange and trade opportunities.

**Provision of local employment in one of Ghana's growing industries**

**Diversification of the energy mix**

Production and onshore distribution of associated gas will help to reduce the country's power shortages.

*Source:* IFC (n.d. b)

IFC's Financial Contributions

For its financial investment in Jubilee, the IFC collaborated closely with the Multilateral Investment and Guarantee Agency (MIGA) (IFC 2015b). The IFC provided loans to two major project sponsors of the Jubilee Oil Field, Tullow Oil and Kosmos Energy. Both investments supported Phase 1 of the development of Jubilee which had a total estimated cost of US$3.2 billion. Amounting to US$2.6 billion, the costs for drilling and completion as well as subsea facilities account for most of the total investment amount. This includes drilling 17 wells, subsea production installations and leasing a FPSO unit for processing and storing crude oil. Each involved partner had to raise their share of the total costs, while the contribution of the state-owned GNPC was carried by the other project sponsors. Therefore, Tullow was responsible for raising 40% of the total costs (~US$1.3 billion) and Kosmos Energy was responsible for 27% (~US$860 million). (World Bank 2009) Each borrower set up reserve-based lending (RBL) facilities for handling the financing (box G.1).

**Box G.1: Reserve-Based Lending**
RBLs are corporate revolving-debt facilities that allow for unlimited withdrawals, repayments, and redraws of the loan during a specified period, giving the borrower maximum flexibility. RBLs are unique to the oil and gas industry. The collateral is the revenue stream that the borrower has from oil exploitation contracts, and the loan amount is based on the present value of expected cash flows. This assessment in turn relies on the characteristics of the identified hydrocarbons, the production and pricing plan, as well as the available security assets.
*Source:* Investopedia n.d.; O'Donnell 2012.

In 2009, Tullow Oil set up a US$2.5 billion RBL facility for refinancing outstanding commercial bank debt as well as the phase 1 development of Jubilee. This RBL had a US$2.4 billion senior debt tranche and a US$100 million junior debt tranche. IFC initially invested US$115 million in this RBL. The remainder of the funds was raised through commercial bank loans and equity and cash generation. In 2011, Tullow Oil raised the RBL to US$3.5 billion to meet its capital expenditure (CAPEX) needs and IFC increased its contribution by another US$50 million. One year later, the firm refinanced the existing RBL facility and asked IFC to refinance its US$165 million investment (IFC 2015a, World Bank 2009).

Kosmos Energy received a US$100 million loan as part of their US$750 million RBL facility, again in 2009 for phase 1 of the Jubilee Field's development. The remainder of funds required was acquired through commercial bank loans and equity. In 2011, Kosmos Energy set up a new US$2 billion RBL, in which the IFC participated with a US$100 million senior loan. The aim was to expand Jubilee and develop other opportunities in Ghana (IFC 2015a, World Bank 2009).

For the Tullow Oil and Kosmos investments, a base case of US$50 per bbl flat oil price has been assumed. For the financial analyses behind Jubilee's gas, a wellhead price of US$1.25 per million British thermal units (MMBtu) was assumed (World Bank 2009). This would cover the delivery costs of associated gas and would also incentivize upstream investors to refrain from gas reinjection. The marginal cost behind this price is low, mainly consisting of integrating the delivery of associated gas through a pipeline. The GNPC pricing was expected to reflect this (World Bank 2013).

*IFC's Nonfinancial Contributions to the Jubilee Field Development*

To aid Ghana's development, the IFC also supported the Jubilee project in three other areas, apart from direct financial contributions (figure G.4).

**Figure G.4: IFC Contributions to Jubilee**

**Mobilization of funding**

As an anchor investor, the IFC facilitates and motivates other financing, signaling confidence in the project. This also helps the IFC to get in contact with local partners for possible future collaborations. (World Bank 2009)

**Environment and society**

The IFC helps the project sponsors to mitigate their risks by providing their expertise in planning and managing environmental and safety risks. Herein, the focus areas are biodiversity, waste management, oil spill response planning, and community grievance (World Bank 2009). Moreover, this ensures that IFC's own standards are satisfied (IFC n.d. b).

**Benefits for local communities**

By sharing best practices and drawing from IFC's experience, a strategy for livelihood creation ensures greater benefits to the community (World Bank 2009).

*Source:* IFC (n.d. b); World Bank 2009.

*Project Risks*

As the Jubilee Oil Field was the first oil and gas production project of Ghana, all connecting infrastructure, such as transmission pipelines, had to be developed simultaneously. (See box G.2.) This creates a dependency risk and risk of delay.

**Box G.2: Ghana National Gas Company Investment**

In 2010, GNGC was founded to commercialize, transport, and process natural gas in the country. This company then commissioned the project to transport Jubilee's gas to Aboadze. The US$750 million project costs of this were financed by the US$3 billion infrastructure loan from the China Development Bank.

Source: World Bank 2009.

*Investment Project Outcome*

Investing in Jubilee aligned with IFC's objectives for Ghana: by supporting a private investor in the oil and gas industry, additional revenues from the independent oil production and decreased import dependency were achieved. This in turn enabled the country's government to use its monetary and human resources for other infrastructure developments. Moreover, the project supported four out of IFC's five strategic corporate directions at the time (FY 09–11) by being in an International Development Association (IDA) country, building long-term partnerships in the region, and fostering environmental and social sustainability (World Bank 2009).

**Tweneboa Enyenra Ntomme (TEN) Field**

*Project Background*

After Jubilee, TEN is Ghana's second largest field and second production project (Tullow Oil 2016). In 2009, an initial well discovery led to further appraisal and exploration wells that detected TEN. The total recoverable reserves are estimated at about 300 million barrels, with a

plateau peak production of about 80,000 barrels of oil per day (bopd) (World Bank 2015c). Moreover, both associated and nonassociated gas was found (World Bank 2013). The fields that make up TEN lie in the Deepwater Tano block, about 45 kilometers off Ghana's coast and about 20 kilometers west of Jubilee, at a depth of 1,000–2,000 meters (map G.3). (Tullow Oil 2016).

**Map G.3: TEN Field**


*Source:* Tullow Oil 2018b

By adding non-associated gas to the energy mix, the TEN field can further diversify Ghana's power sector and strengthen the country's downstream industry. This in turn increases the stability of power supply as TEN's production of 80,000 bopd raises Ghana's total oil production to 180,000 bopd by 2018 (World Bank 2015c).

*IFC's Financial Contributions*

The gross development costs of the TEN Field to First Oil were budgeted at about US$4.9 billion. This includes the drilling and completion of up to 24 wells, which will then be connected to an FPSO vessel with a maximum production capacity of 80,000 bopd. For the timely completion of the project, Tullow Oil needed to invest its share of CAPEX between 2015 and 2016, amounting to about US$1.5 billion. At that time, the oil and gas industry was in a limbo, and the IFC's existing investment helped ensure Tullow Oil's liquidity.

By agreement with Tullow, IFC's investment proceeds to the RBL were only ever earmarked for the Jubilee development, but as the RBL served as Tullow's primary corporate facility, IFC's continued commitment under the RBL was critical to ensuring Tullow's overall corporate liquidity and ability to finance the TEN development from other sources. In 2012, Tullow Oil's US$3.5billion RBL facility consisted of a US$3.4 billion senior secured tranche (senior RBL) and a US$100 million junior secured tranche (junior RBL). In 2012, the IFC joined a syndicate of 26 commercial lenders by investing US$165 million in the senior RBL ($115 million rolled exposure and $50 million additional). As one measure to uphold liquidity and operation of TEN, Tullow Oil increased the junior RBL by US$200 million and asked for IFC's participation in 2015, although IFC ultimately did not invest in the junior tranche, whereas it did maintain its commitments under the senior tranche. Other measures included extending commencement of debt amortization until 2017 and expanding its revolving corporate facility by US$250 million.

To evaluate the RBL base case, modest oil price assumptions were utilized, ranging from US$50–65 per barrel from 2015 onward. This lies below World Bank projections (World Bank 2015c).

With TEN, the minimum gas price could be reduced, leading to an assumed wellhead price for TEN's gas at US$6.00 per MMBtu. A mark-up of US$1.00 per MMBtu is assumed on top, to cover the assumed transportation costs to Takoradi (World Bank 2013).

*IFC's Nonfinancial Contributions*

Apart from direct financial contributions, IFC has provided additional support toward Ghana's development (figure G.5) (World Bank 2015c):

**Figure G.5: IFC Contributions to TEN**

**Facilitating project completion**

Continued IFC commitment to the RBL facility ensures Tullow's liquidity and timely completion of First Oil.

**Mobilization of long-term financing**

IFC's continued commitment to the RBL reassures the lender syndicate.

**Countercyclical role**

IFC's participation upholds Tullow's liquidity and ability to raise capital from commercial banks.

**Guidance on environmental and social aspects**

Guidance is provided to mitigate operational risks and comply with performance standards.

*Source:* World Bank 2015

*Project Risks*

The risks associated with the TEN Field are the uncertainty of gas volumes and timing which will not be known until development and production progress further (World Bank 2013). Moreover, Ghana's involvement in a maritime boundary dispute with Côte d'Ivoire poses an uncertainty. A final ruling is expected in September 2017 (World Bank 2015b). Lastly, Tullow Oil's liquidity and thus ability to fulfill its debt is closely tied to the oil price. This connection and its implications were visible in 2015, when the firm refinanced its RBL facilities. (World Bank 2015c).

*Project Outcome*

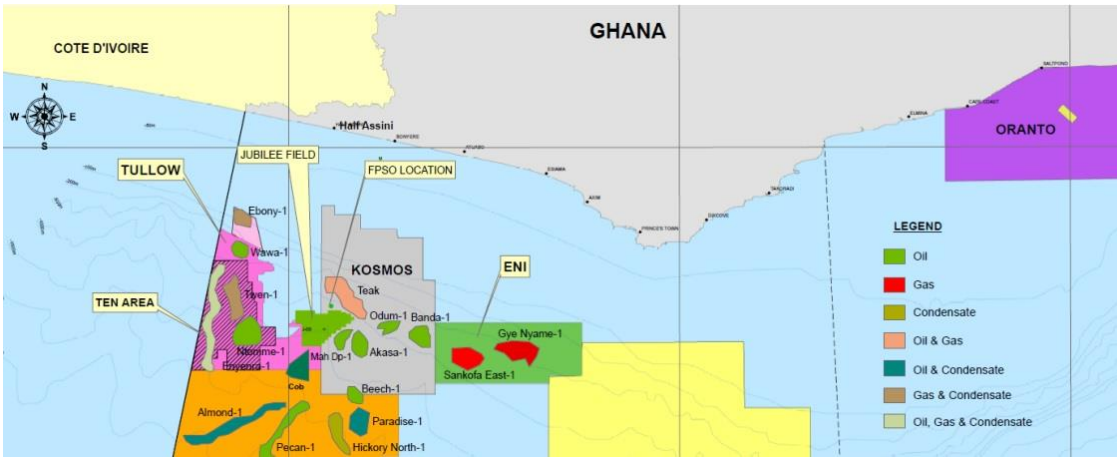
The TEN project contributes to the IFC's policy goals relating to the oil and gas industry, Africa, and Ghana by enhancing structural transformation, job creation, and private sector efficiency (World Bank 2015c). Major benefits from IFC's investment in the TEN field was the following: by enabling the increased production and distribution of gas, the project diversifies the country's energy mix and reduces power outages. In developing the TEN Field, emphasis was placed on using local resources, content, knowledge, and partners (Tullow Oil 2016).

## Sankofa Field

*Investment Background*

The Sankofa Gas Field is part of the OCTP block, located about 60 kilometers off Ghana's coast in deep waters (map G.4) (Eni 2016, World Bank 2015a). This block holds about 500 million barrels of oil and 1.5 trillion cubic feet of non-associated gas (Eni 2016). OCTP encompasses the Sankofa East oil field and the Sankofa gas field, which in turn entails the non-associated gas fields of Sankofa and Gye Nyame (World Bank 2015b). While both fields are operated by the same project partners and share an FPSO vessel, the commercial arrangements for the oil and gas fields are strictly separated.

**Map G.4: Sankofa Gas Field**




*Source:* Gondwana Oil, Ghana Govt in Negotiation for Tano Basin Block 2014

Sankofa's non-associated gas supply is the base-load to power up to 1,000 MW of power generation capacity which is about 40% of Ghana's current total generation capacity (World Bank 2015a,b). Takoradi, which will be the place of gas consumption, will increase its thermal capacity from 500 MW to 2,000 MW as Ghana's government invests heavily into its IPP development program. Yet, the gas deficit will continue nationally, making additional LNG imports or other sources of supply necessary (World Bank 2015b). The OCTP block will supply low-cost domestic gas to national thermal power plants in the long term, for more than 15 years (Eni 2016, World Bank 2015b). This helps to meet the country's energy requirements, particularly in urban and rural areas, which will in turn foster Ghana's industrial development (Eni 2016). Apart from that, the US$2.3 billion of generated gas revenues will aid the infrastructure financing opportunities of the government (World Bank 2015a). These revenues are expected to impact Ghana's balance of payments and subsequently reduce the pressure on the national currency. This will then enhance debt sustainability, given the composition of public debt (World Bank 2015b). However, compared to the magnitude of Jubilee, Sankofa's contributions to government revenues are minor (World Bank 2013). As such, the Sankofa (Gas) project has been listed a top priority by the World Bank (Eni 2016).

*IFC's Financial Contributions*

The lifetime cost of the total development of the OCTP block is estimated at about US$7.9 billion, making it the largest foreign direct investment in Ghana's history (World Bank 2015a,b). This cost includes the lease for the FPSO vessel as well as the required investments to maintain the gas plateau level production (World Bank 2015a,b). While the OCTP is developed via an unincorporated joint venture between the private sponsors Eni and Vitol, each partner must finance its share of capital. This includes carrying GNPC's 15 percent capital share at no cost. The remaining 5 percent GNPC shares will initially be financed by the partners but later be repaid with the oil revenues and shares from the gas sales. As oil production was expected to begin in late 2017, parts of the total costs will finance themselves through the resulting revenues. The OCTP integrated oil and gas development plan splits the work into two phases: phase 1 for oil development and phase 2 for natural gas development. Through these two phases the technical development is split and the commercial operation dates as well as the costs are split. Out of the total US$7.9 billion capital costs, phase 1 (oil) costs are estimated at US$3.9 billion and phase 2 costs (gas) at US$4 billion. (The combined CAPEX to start operation of both fields is US$3.9 billion.) (World Bank 2015b).

The private sponsors raised their capital share of the costs through a mix of equity, shareholder loans, and commercial debt (World Bank 2015b):

- Eni: US$2.2 billion through equity and shareholder loans
- Vitol: US$1.7 billion through equity, shareholder loans, and a limited recourse commercial debt financing (which might involve international financing corporations, including the IFC)

In 2015, the World Bank Group was asked to issue a World Bank Guarantee for US$700 million, to help mitigate the repayment and political risks as well as the costs of GNPC capital share. This guarantee was split between a US$500 million IDA guarantee, against defined risk coverage, and a US$200 million International Bank for Reconstruction and Development (IBRD) enclave loan guarantee. Both the IDA and the IBRD are part of the World Bank Group. The final maturity of both guarantees was set at 22 years with no grace period. While the IDA guarantee covers the risk of GNPC nonpayment according to the Gas Sales Agreement (GSA), the IBRD guarantee supports the private sector by covering the risk of contractual breaches by the GNPC and government (World Bank 2015a,b). Both guarantees will facilitate raising the remaining US$7.9 billion from the private sector as larger gas payment flows can be leveraged over the 20-year contract period.

After the World Bank Guarantees' security package was executed, IFC invested US$235 million in Vitol, to support the company in meeting its CAPEX needs. Additionally, the IFC raised US$65 million from the Managed Co-Lending Portfolio Program, which enables third-party investors to participate passively in IFC's senior loan portfolio. This IFC financing belongs to a US$1.35 billion loan facility provided by commercial banks. Again, the IFC worked closely with MIGA, which issued guarantees for up to US$217 million and up to 15 years against political risks. This supported Vitol's attraction of commercial lenders (IFC 2017). All support by the WBG, IFC, and MIGA aimed at reassuring private investors, thus underpinning a US$7.9 billion investment (World Bank 2015b).

The GNPC will buy Sankofa's gas and then resell it to the downstream power sector. The off-take price, as negotiated in the GSA between the private sponsors and GNPC, is US$9.80 per MMBtu. This price includes the government's substantial fiscal take from Sankofa, which aims at maximizing the resource rent from using nonrenewable resources while keeping the price competitive. This GSA agreed price has been an assumption behind all financial analyses. Ghana's net costs of gas are estimated at US$6.60 per MMBtu, which is much lower than alternative (current gas import price from Nigeria US$8 per MMBtu, LNG import US$10 per MMBtu, liquid fuel alternatives US$12 per MMBtu). While the oil commercialization of Sankofa is not part of WBG contributions, it is notable that a weighted average oil price during the Sankofa production period of US$68 per barrel has been assumed (World Bank 2015b).

*IFC's Nonfinancial Contributions*

Apart from direct financial contributions, technical and regulatory assistance as well as expertise in off-grid and distribution operations was provided (IFC 2017). Moreover, environmental, health and safety guidelines have been provided and an assessment of environmental, health and safety, and social factors was conducted (World Bank 2015a).

*Project Risks*

The risks associated with the project are identified as: timely connective infrastructure completion, GNPC non-payment, GNPC or government breach of contracts, as well as the ongoing, long-term political tensions in the country. As Jubilee and TEN will be in full production when Sankofa's gas comes on-stream in 2018, there is a substantial offtake risk. In order for the gas to be absorbable, an additional 700 MW of open cycle generation capacity (1,200 MW

combined cycle) are needed at Takoradi. However, there is doubt over the timely completion of this infrastructure. Moreover, delay in the midstream infrastructure (two-stage compressors) could lead to a situation where gas could not be transported to Takoradi in the first place. As the financing for a third compressor was not secured in 2015, this risk remained (World Bank 2015b).

*Investment Project Outcome*

The WBG cooperates heavily with the Ghanaian government to foster the country's energy sector development (World Bank 2015b). Hereby, the Sankofa Gas Project majorly contributes to IFC's social and environmental goals, fulfilling its Performance Standards on Environmental and Social Sustainability. Through delivering infrastructure services that generate accessible energy and create jobs, ultimately reducing poverty, the social targets are met. Moreover, Ghana's government can expect revenues up to US$2.3 billion which can then be reinvested in further infrastructure projects (World Bank 2015b). Regarding the environmental aspects, Ghana will be able to decrease its $CO_2$ emissions by around 8 million tons over five years by replacing the polluting fuels with larger and more affordable gas resources. This will also enable the country to meet its commitment to the Paris Agreement (World Bank 2015a).

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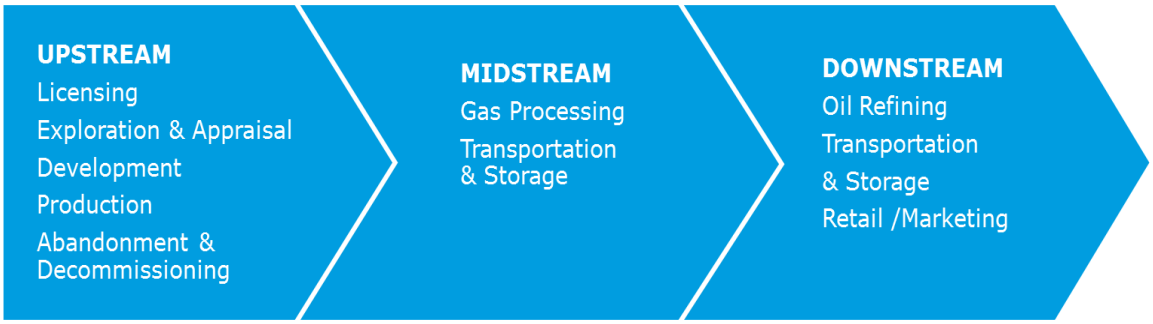
# APPENDIX H: TYPICAL COMPONENTS OF AN OIL AND GAS VALUE CHAIN

## Overview

The value chain for the oil and gas sector follows the life cycle of fossil fuels from their discovery to their point of consumption and is divided into three main parts: upstream, midstream, and downstream. Key activities under these three parts are depicted in figure H.1.

**Figure H.1: Typical Offshore Oil and Gas Value Chain**



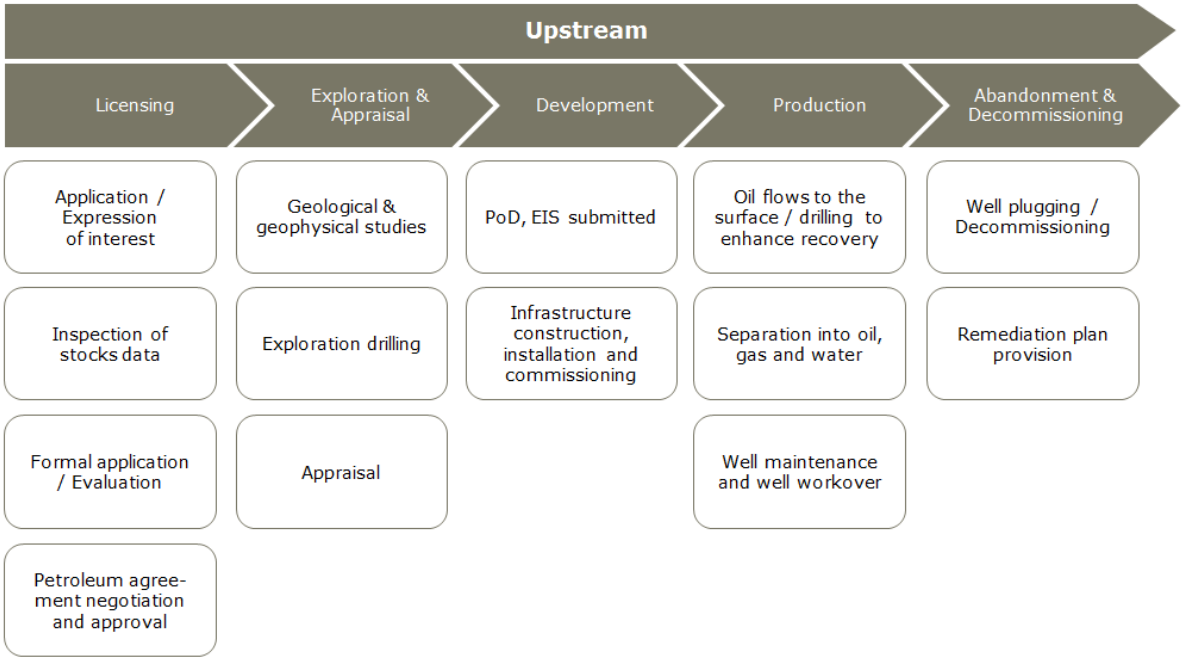

This appendix provides a generic overview of a typical offshore oil and gas value chain, providing the context for the analysis of the value chain that has been developing in Ghana since the discovery of commercial fields.

## Upstream

The upstream part starts with the identification of the areas where fossil fuels can be economically and sustainably extracted. Following the initial exploration of these areas, oil fields that can be used commercially are appraised and developed, and production starts. This phase is also known as exploration and production (E&P). Upstream activities are generally capital intensive in terms of investment as well as demanding in terms of technology and equipment. Geological and geophysical surveys produce initial seismic and non-seismic data; exploratory drilling then takes place to confirm findings of seismic surveys. Another round of large investments is required to develop the field before production can commence.

Key activities are illustrated in figure H.2.

**Figure H.1: Typical Offshore Oil and Gas Value Chain**




*Note:* PoD = Plan of Development; EIS =Environmental Impact Statement

*Licensing*

In most countries, the oil and gas resources belong to the state. The E&P companies interested in extracting these resources should acquire the appropriate rights for the exploration. The procedures followed for these licenses are different in each country but in general can be reduced to three concepts (Olesen 2015):

1. The state under the concessionary system can grant E&P rights to public or private companies, which can undertake the operation of the fields they may discover.
2. The state can nationalize the production by having a national oil company undertake the operation of the field.
3. The state can also nationalize the production by granting the right to the private company for the exploration and production of the field on behalf of it by signing a product sharing agreement. (This licensing procedure is usually followed in developing countries.)

*Exploration and Appraisal*

After the interested parties acquire the appropriate rights following one of the procedures, exploration starts. This includes geological and geophysical studies and, specifically, seismic surveys to detect hydrocarbon reserves (Penplusbytes 2017).

Geophysicists gather the data of the subsurface formations and map them to predict where high concentrations of oil and gas reserves are most likely to be found, by creating seismic 2D and 3D imaging.

Following the seismic surveys' success, a crucial step is the exploration drilling. During the exploratory, drilling rigs (either onshore or offshore, the latter to varying depths) are used together with a considerable number of ancillary equipment, products, and services associated with this activity (Tordo, Tracy, and Arfaa 2011).

Finally, the last phase of exploration involves appraising the reservoir. During appraisal, more seismic data may be initially gathered, followed by drilling of appraisal wells. The data acquired during the drilling phase provide an estimate of the quantities of hydrocarbons that can be recovered by the reservoir and its producibility (GNPC 2016). (The reserve type is determined, for example, proven 1P, possible 2P, and so forth.) Finally, an economic assessment follows to assess the reservoir's commercial potential, so that a final decision can be made on developing the resource.

*Development*

Once it has been proven that the oil discovery is commercially feasible, a Plan of Development (PoD) is prepared. This plan, also called the Field Development Plan, considers all the technical, economic, and environmental aspects of the development and provides a plan for developing the oil and gas field under examination. The PoD usually includes the geological findings, a description of the reservoir by a strict engineering design, recoverable rate of the reserve and field life, field development scenarios, and production facilities (number and type of wells, surface facilities, and so forth).

The development of a hydrocarbon field is commonly divided into the following stages:

1. Before the final investment decision (pre-FID)
    a. Concept
    b. Front-end engineering design (FEED)
2. Final investment decision (FID)
    a. Detailed design
    b. Commissioning

During the development process, hazard and operability studies (HAZOP) and the schedule and financials of the project are developed. These aspects become increasingly detailed as more information becomes available during project development. PoDs generally need to receive the approval of the relevant government institution prior to FID (Business World 2013).

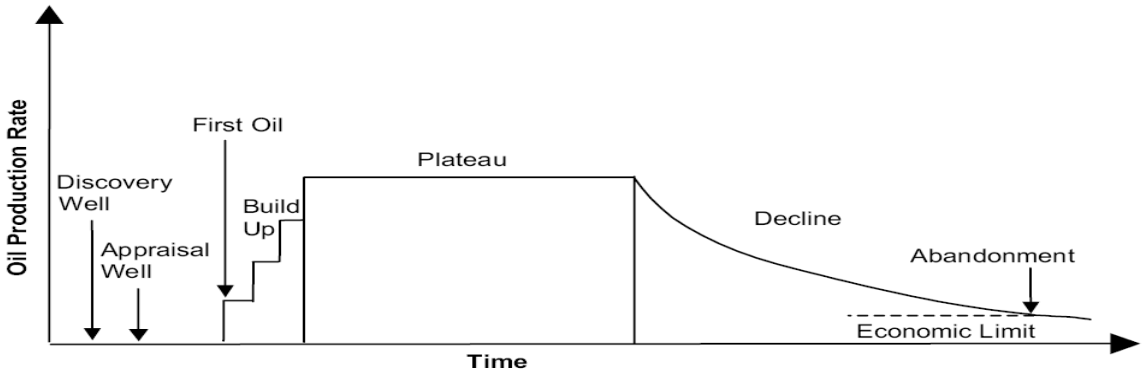
Since the development and production phases usually last for very long (20–60 years), they can highly impact the environment. Therefore, an Environmental Impact Statement (EIS) to be submitted by the international oil companies (IOCs) is crucial. This ensures that the impact the field's development and production will have on the environment is minimized.

After the PoD and EIS documents are approved, the construction of relevant infrastructure begins. The production phase is long term, and therefore the temporary facilities and workforce used in exploration are replaced by permanent facilities and the workforce is usually accommodated in the local area (E&P and UNEP 1997). The development wells require the same drilling procedure as in the exploration drilling, but the procedure is more extensive. This is because the number of development wells is usually high, while the actual wells are more complex compared to the ones drilled during exploration, which are often intended only for exploration and are plugged after the exploration drilling ceases. Most of the equipment used in the development phase (for example, drilling rig, heavy drill pipe, blowout preventer, and so forth) must be replaced by the equipment necessary for production (production rig, lighter weight tubing, and control valve assembly called the "Christmas tree"). When these facilities are ready, their installation and commissioning are the final steps before production starts. Production wells bring the oil and gas to the surface. These wells are connected through wellheads, manifolds and pipelines to a floating production storage and offloading (FPSO) unit (Irvine, de Jong, and Armah 2009). The FPSO is used to process and store crude oil, which is then transported by tankers or export pipelines.

*Production*

In the production phase, hydrocarbons start naturally flowing to the surface (primary recovery using natural pressure). Oil production stages are illustrated in figure H.3. Production increases during the build-up phase, and later it reaches a plateau, remaining constant for a period. Finally, the reservoir's pressure is reduced and production declines until it reaches the economic limit when the production revenue does not cover the operational cost. The plateau phase of production is different for every oilfield and depends on many factors, such as the size of the field or the quality of the oil produced. It can be expanded by using secondary recovery, where water is injected into the reservoir to increase the pressure and boost the recovery rate. Then, tertiary or enhanced recovery is used to increase the pressure needed to produce the remaining hydrocarbons. This method uses steam (thermal recovery) to stimulate the flow of the hydrocarbons to the surface. Another approach to tertiary recovery is using gas or chemical injections into the reservoir to activate the hydrocarbons.

**Figure H.3: Oil Production Stages of Oil Resource Extraction Development**




*Source:* Höök 2009.

Once extracted, hydrocarbons are transferred to the FPSO for further processing. The produced fluid is separated into its main components:

- Crude oil
- Gas
- Water

Crude oil is stored on board until it is exported. Gas is used in different ways, depending on the volumes available. Small amounts are commonly used as fuel gas to supply the FPSO with electricity or to stimulate the reservoir pressure. Larger amounts can be exported or in some cases used to stimulate an oil reservoir and then retrieved and exported at a later stage. The water injection facility is also located on the FPSO and it collects seawater, filters it, and uses it to enhance oil recovery in the reservoir.

Monitoring, safety, and security programs and maintenance of the wells are required during the operational phase. A workover is necessary for maintaining the field and includes several tasks: potential leaks in the tubing are repaired, the wellbore is cleaned, and any acids must be neutralized before their disposal, among others.

*Abandonment and Decommissioning*

The field after a long period of operation reaches its economic limit must be abandoned. Most countries have regulations related to the decommissioning phase specifying that all infrastructure built during the development phase must be removed. Some examples of this

activity are the following: the closure of production and injection wells, the deportation of production equipment, removal of pipelines and other facilities, and management of any remaining production waste. Common international practice at present, for example, in the North Sea, is that pipelines are flushed and left in-situ.

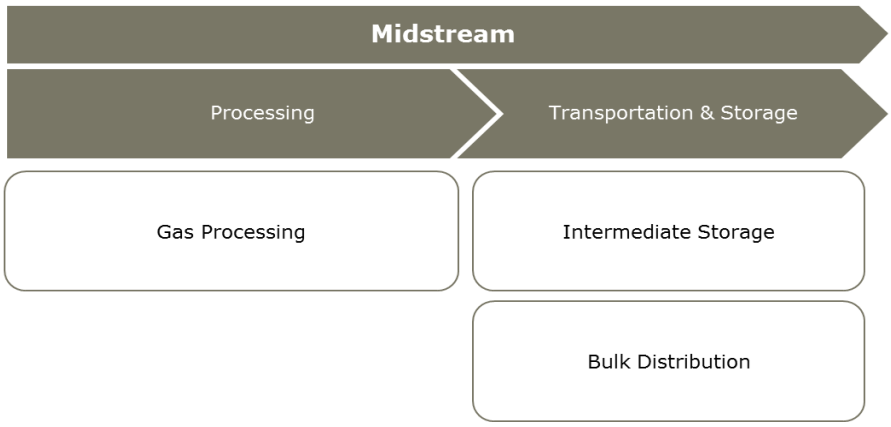
**Midstream**

Transport and storage infrastructure is developed and utilized at various parts of the value chain, linking production and processing facilities to the final customers. Transport and storage are generally referred to as *midstream*.

It is often the case that midstream does not appear as a separate segment in the context of oil and gas. The distinction is more evident in the gas value chain, as gas processing is classified as part of the midstream segment.

An overview of the activities and infrastructure requirements relevant to the midstream segment are illustrated in figure H.4.

**Figure H.4: Midstream Oil and Gas Sector**




*Oil Transportation and Storage*

The Midstream sector provides an integral link between the upstream and downstream sectors, and it includes all transportation activities between the oil wellhead and the refinery. The crude oil remaining from the separation on the FPSO in most countries is then exported or transported for inland refinement into its products.

*Gas Processing*

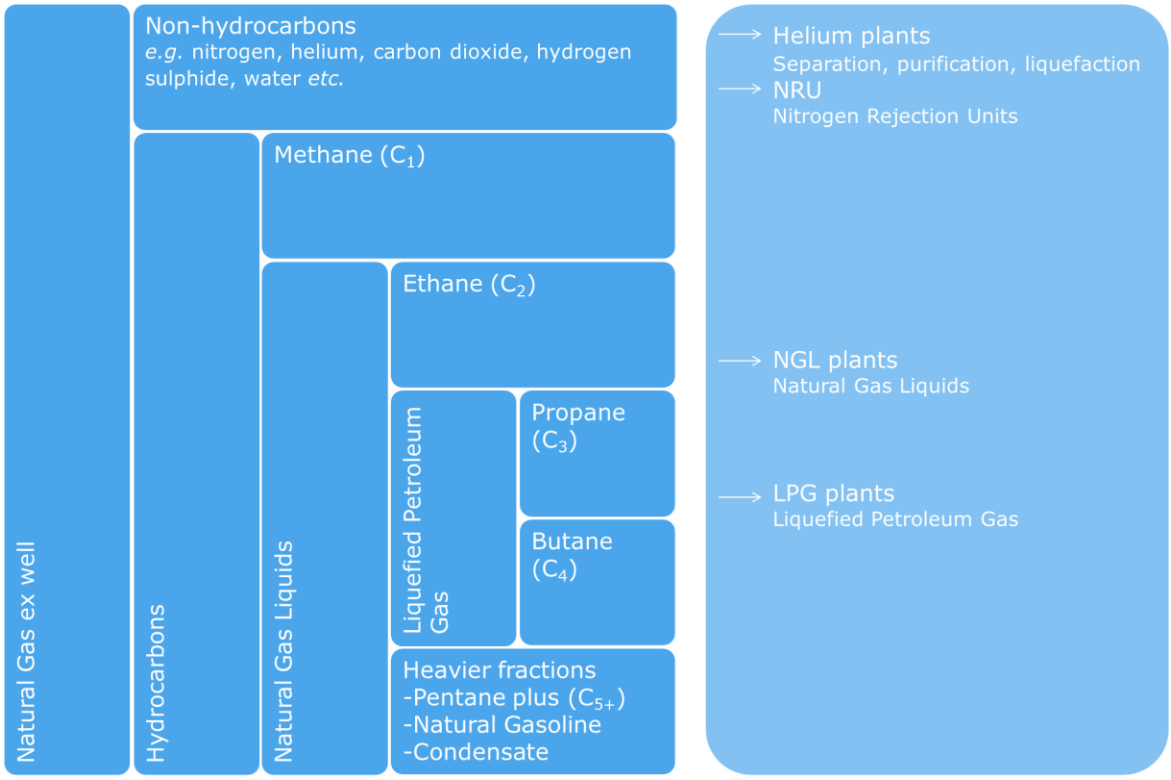
Natural gas comprises a mix of primarily hydrocarbons and other gases. Once extracted, natural gas is transmitted via pipelines for processing and treatment. This involves conditioning and treating the gas to remove other gases and by-products and bringing it to the desired product form that meets the standards imposed by transportation pipelines. This can then be transported safely to its intermediate or end destinations.

In general, gas processing is a complex process, comprising several steps depending on the composition of the natural gas stream extracted from the wells. The processing of wellhead natural gas and its conversion into pipeline-quality dry natural gas involves a series of processes to remove oil and condensate, water, elements such as sulphur, helium and carbon dioxide, and natural gas liquids. In addition, scrubbers and heaters may be required to be installed at or near the wellhead to deal with sand and large-particle impurities and to maintain an optimal temperature for natural gas to avoid the formation of natural gas hydrates that may impede the process (EIA 2006).

Wells on a facility are connected via a gathering system. A natural gas processing plant will typically receive gas from a gathering system and send out processed gas and natural gas liquids to their respective destinations via interconnected pipelines.

Figure H.5 illustrates the production portfolio of natural gas processing plants.

**Figure H.5: Portfolio of Natural Gas Processing Plants**




*Source:* Adapted from Linde Engineering (n.d.), "Natural Gas Processing Plants" brochure.

Natural gas liquids (NGLs) are associated hydrocarbons that can be valuable by-products of natural gas processing. NGLs are generally more valuable in other uses (for example, as feedstock for a large array of goods or as fuel for heating and cooking) rather than as produced gas, and it makes economic and commercial sense to separate, treat, and sell them as separate products. Table H.1 provides information on common types and applications of NGLs.

**Table H.1: NGL Attribute Summary**

| Natural gas liquid | Chemical formula | Applications | End use products | Primary sectors |
|---|---|---|---|---|
| Ethane | $C_2H_6$ | Ethylene for plastics production, petrochemical feedstock | Plastic bags, plastics, anti-freeze, detergents | Industrial |
| Propane | $C_3H_3$ | Residential and commercial heating, cooking fuel, petrochemical feedstock | Home heating, small stoves, LPG | Industrial, residential, commercial |
| Butane | $C_4H_{10}$ | Petrochemical feedstock, blending with propane or gasoline | Synthetic rubber for tires, LPG, lighter fuel | Industrial, transportation |
| Isobutane | $C_4H_{10}$ | Refinery feedstock, petrochemical feedstock | Alkylate for gasoline, aerosols, refrigerant | Industrial |
| Pentane | $C_5H_{12}$ | Natural gasoline, blowing agent for polystyrene foam | Gasoline, polystyrene, solvent | Transportation |
| Pentanes Plus* | Mix of $C_5H_{12}$ and heavier | Blending with vehicle fuel, exported for bitumen production in oil sands | Gasoline, ethanol blends, oil sands production | Transportation |

*Source:* EIA 2012.

*Pentanes Plus is also known as "natural gasoline." It contains pentane and heavier hydrocarbons.

NGLs have a similar chemical composition, yet their applications can vary widely, reaching almost all sectors of the economy. The majority of NGL field production is ethane, which is used for the production of ethylene, which is then converted into plastics. Propane is mainly used as heating fuel or feedstock for the production of plastics. Natural gasoline is a widely used blending agent to produce fuel of various kinds for different kinds of engines. LPG can be used as a fuel for cars and cooking stoves and is also suitable as a chemical feedstock.

*Gas Transportation and Storage*

The processed gas that meets specified quality standards is transported to end users using gas transmission pipelines. It can be transported in its gaseous phase through medium and high-pressure pipelines, or in liquefied natural gas (LNG) carriers if in liquid state. The gas chain is more complex and expensive in the latter case, as it requires liquefaction, shipping, and, if not used directly as LNG, regasification is also necessary.

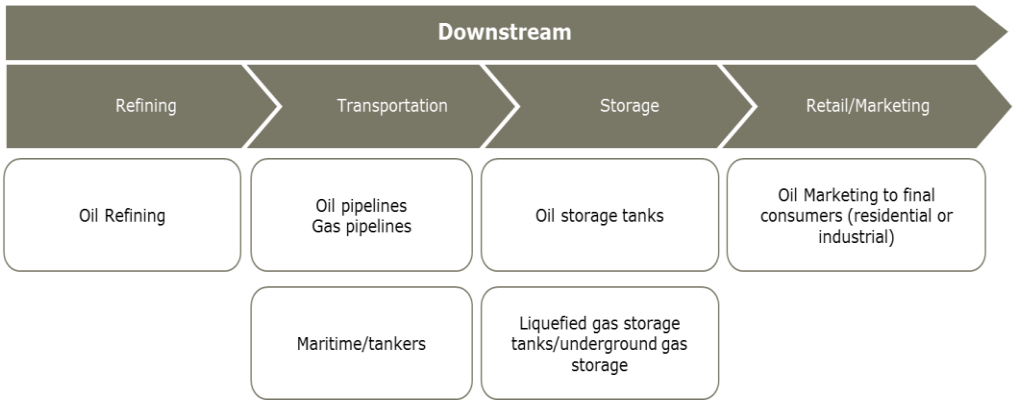
The most common transport method for gas is via pipelines. If the right volumes and demand is present, this is the most cost-efficient form of transport. When the construction of gas pipelines is technically challenging or volumes are not sufficient, other gas is transported as LNG via ship, train, or truck.

Gas storage is essential to maintain the security of supply during peak demand and to account for seasonal fluctuation. Gas is often stored in underground reservoirs, which can be different types of formations—for example, salt caverns of aquifers—or it can be stored in high-pressure steel bullets as LNG.

## Downstream

The final part of the value chain, known as downstream, corresponds to activities relating to refining extracted oil into usable products, which are then distributed to industrial, wholesale or retail customer. Figure H.6 illustrates the downstream segment's key links and activities.

**Figure H.6: Downstream Oil and Gas Subsector**



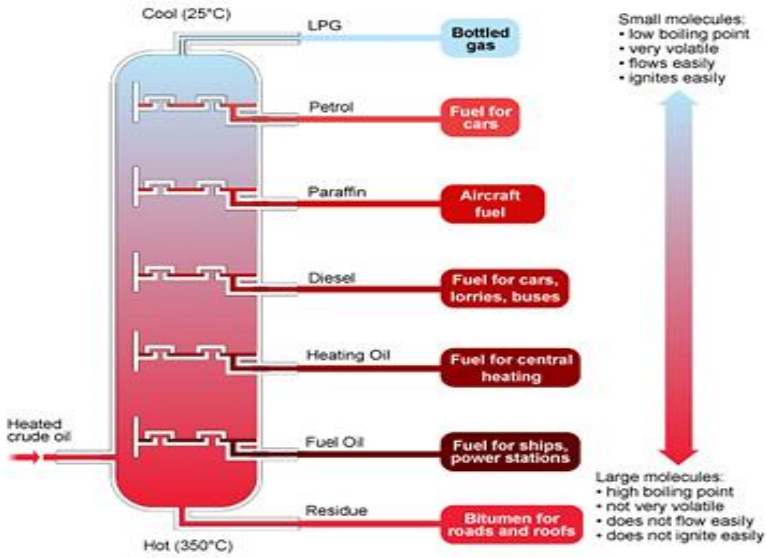

*Oil-Related Activities*

The downstream oil sector consists of oil refining, distribution, and marketing of the petroleum products.

Oil Refining

Oil refinement is the process of converting crude oil into useful products and it is divided into three operations: separation, conversion, and treating. In the separation, the hydrocarbon molecules are separated depending on their molecular weight. Specifically, the oil is heated at very high temperatures inside a distillation column and molecules convert into liquids and gases figure H.7. The different liquids (lighter as you move up) created in the column are gathered in trays. The heavy residuals undergo another distillation to convert into heavy fuel oil and diesel (Planete Energies 2015).

**Figure H.7: Illustration of the Oil Refinement Process**




*Source:* BBC n.d.

Conversion is the second step of oil refining. Under this process, the heavy molecules left after separation are heated to extremely high temperatures (for example, 500°C) and a catalyst is used to convert these molecules into lighter products such as gas, gasoline, and diesel (catalytic cracking). This process can be enhanced by using hydrogen (hydrocracking) or by removing the carbon (deep conversion). Finally, treating includes removing of air pollutant molecules such as sulphur (desulfurization) from the final products.

Oil Transportation and Storage

Transportation of oil and gas is usually made by pipelines, marine tankers, railways, and trucks. Pipelines are the most common way of transporting oil to the marketplaces. Pressure circulates the oil via compressor or pump stations, allowing oil to travel in the pipelines. Pipelines are a safe, efficient, and economical way of transportation (Kumar 2014). Maintenance is very crucial for pipelines, since they travel across mountains, deserts, swamps, and other rugged territory; they need special treatment to prevent cracking, which could have catastrophic economic and environmental consequences (STI Group 2013).

Marine tankers are also used to transport oil. Companies usually choose the largest marine vessel for the transportation to benefit by economies of scale. This method can be time consuming, but it is the most efficient for transporting oil over oceans.

Rail and trucks are sometimes used for oil transportation. They need access railways and roads, but other than that they are cost-effective methods to transfer oil fast to different destinations within the country.

Storage of oil appears in every step of the value chain. In the upstream, crude oil is stored in storage facilities until it is exported or transferred to refineries, and in the downstream crude oil is stored in storage tanks until refined.

*Gas-Related Activities*

For gas, the downstream subsector comprises distribution activities to gas off-takers such as industries, distribution companies to residential and commercial users, or power plants where it can be used as fuel for power generation.

Retail Marketing

Retail marketing involves the sale of petroleum products to final consumers. There are typically two types of consumers: residential consumers and large industrial consumers. In the residential sector, fuel is mainly used for transportation, domestic heating, and cooking. In the industrial sector, petroleum products are used for power generation, heating and lighting, lubricants, and so forth. Retail companies receive final products from the distribution companies and sell them to the final consumers either directly or through service stations and heating-oil distributors.

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# APPENDIX I: THE GHANAIAN OIL AND GAS VALUE CHAIN

### Introduction

This appendix describes the value chain links present in Ghana since the discovery of commercially exploitable hydrocarbons fields in 2007. Part 1 describes activities under each of the three subsectors: upstream, midstream, and downstream. Policy, regulatory, and industry stakeholders relevant along the chain are then presented in part 2. Part 3 outlines key elements of the local content regulations in force in Ghana, to set the context for local participation requirements in the country.

## Part 1: Ghana's Oil and Gas Value Chain Activities

### Upstream

*Licensing*

Ghana applies the "first-come-first-served" type of negotiation when international oil companies (IOCs) express an interest in its oil and gas reserves (Boas 2015). IOCs apply to the Ministry of Energy (MoE) for an offshore or onshore block. The applying IOC may then be invited to make a presentation to the Petroleum Commission (PC) and, if successful, be invited to visit the Data Room to examine data on available stocks for a nonrefundable fee of US$1,000 (Cameron McKenna 2016). The next step involves the submission of a formal application to the MoE for the block of interest together with a payment of a US$10,000 fee. Ghana National Petroleum Corporation (GNPC) and the PC evaluate the application and send their evaluation to the minister for further consideration. If the application is successful, a negotiation team comprising the PC, GNPC, and MoE, is set up by the minister to negotiate the petroleum agreement with the applicant. Following the negotiations, the draft petroleum agreement is prepared and further discussions with the minister, minister of finance, minister of justice and attorney general, and the minister of environment, science and technology are held. The petroleum agreement finally is approved by the Cabinet, and it is signed by the parties before it is sent to the parliament for ratification.

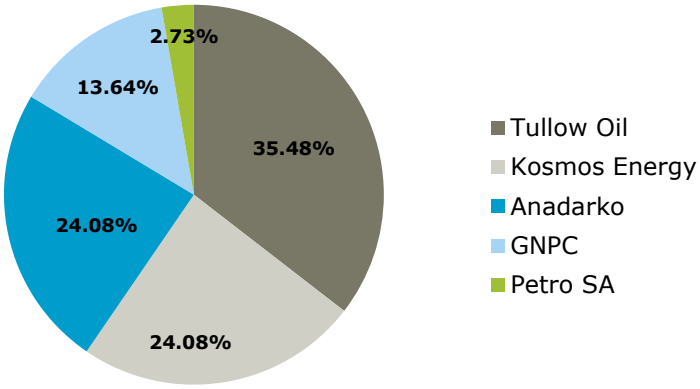
*Exploration and Appraisal, Development, and Production*

Jubilee, TEN, and Sankofa are the three field developments in progress in Ghana relevant to this study. Listed below are specific details on the exploration, development, and production activities.

Jubilee Oil Field

The Jubilee field straddles two license blocks, leading to an equal share of revenues and costs between the partners of each block and split operator responsibilities: While Tullow Oil, as operator of Deepwater Tano, was appointed unit operator of Jubilee, Kosmos Energy, as operator of West Cape Three Points, was appointed technical operator. All current participating interests of the Jubilee Oil Field are shown in figure I.1.

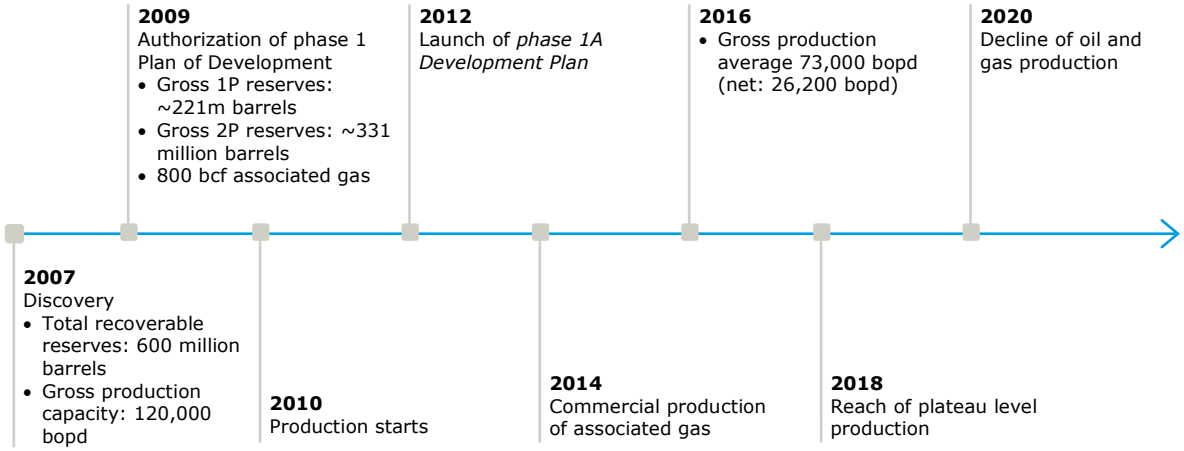
**Figure I.1: Participating Interests in the Jubilee Oil Field**




*Source:* Tullow 2018

Figure I.2 illustrates the timeline of events in the development of the Jubilee Field, from discovery to forecast, including estimated production levels.

**Figure I.2: Jubilee Timeline Overview**




*Source:* Created based on World Bank 2009; World Bank 2015; and Tullow Oil 2017.
*Note:* 1P = indicated proven; 2P = proven and probable reserves; bcf = billion cubic feet; bopd = barrels of oil per day.
*Production levels and statuses are past or future estimations.

The field's phased development enabled the necessary early production start while keeping risks low through continuous learning and adaptation opportunities. The initial discovery in 2007 entailed estimated total recoverable reserves of about 600 million barrels and an estimated gross production capacity of 120,000 barrels of oil per day (bopd) with an expected increase (World Bank 2009).

In 2009, Ghana's Ministry of Energy authorized the *Phase 1 Plan of Development* which involved a floating production storage and offloading (FPSO) vessel at the estimated production capacity. At this time, Jubilee was estimated to have gross indicated proven reserves (1P) of about 221 million barrels of oil and proven and probable reserves (2P) of about 331 million barrels, with about 800 billion cubic feet (bcf) of associated gas resources. Moreover, it was estimated that the natural gas reserves exceeded 840 bcf, with a capability to supply about 80 million cubic feet per day (this equates to supply for up to 400 megawatts [MW] of gas-fired power

generation) once the field is further explored and necessary infrastructure available. These 400 MW are equivalent to over 50 percent of Ghana's power consumption in 2009 (World Bank 2009). However, since production started in 2010, Jubilee has not met the 120,000 bopd design capacity (export to shore), owing mainly to an untimely completion of the pipeline.

To leverage further reserves and increase production, the *Phase 1A Development Project* was approved in 2012, involving the drilling of eight additional wells (Tullow Oil 2017a). Yet, Jubilee still had significant production deficits in 2013, as gas had to be reinjected, necessitating an expensive remediation program (World Bank 2013). In 2014, commercial production of associated gas commenced with ~100 million cubic feet per day (mmcfd) expected from 2015 until 2018. In 2015, the production of oil was at 100,000 bopd (World Bank 2015b), and about 50 million standard cubic feet per day (mmscfd) of natural gas were supplied to the domestic market (World Bank 2015c). In 2015, the *Greater Jubilee Full Field Development Plan* was proposed to adjust the extension of the field to the oil price movements, as well as decrease the entailed capital requirement and increase the flexibility on the timing of capital investment. A decision by the Ghanaian government is expected in 2017(Tullow Oil 2017a).

In 2016, gross production averaged at 73,700 bopd (net 26,200 bopd) (Tullow Oil 2017a). In the same year, the operators decided to convert the FPSO unit to a permanently spread moored facility due to technical issues. This would require an estimated 12-week system shutdown in 2017. Including that downtime, the production is expected to average 68,500 bopd (net: 24,300 bopd), with insurance covering the cost of loss of production. The equivalent average annualized net production then is about 12,000 bopd, increasing the effective net production to about 36,300 bopd, including insured barrels. (Tullow Oil 2017a) By the first half of 2018, Jubilee should be well into plateau level production, ultimately leading to a decline of the oil and gas production from 2020 onwards (World Bank 2015b).

TEN Field

The TEN Field is also operated by Tullow Oil and has the same project sponsors as Jubilee. Currently, all participating interests of the TEN Oil Field are shown in figure I.3.

**Figure I.3: Participating Interests in the TEN Oil Field**

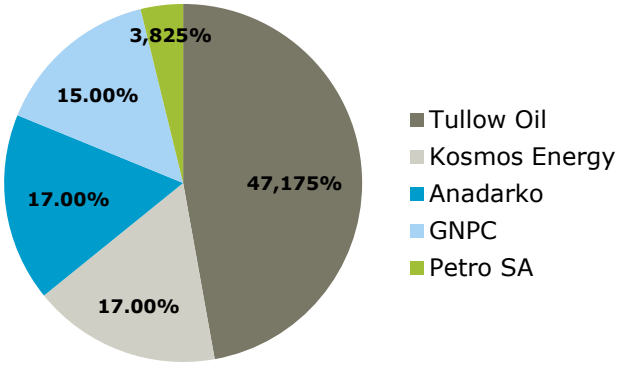
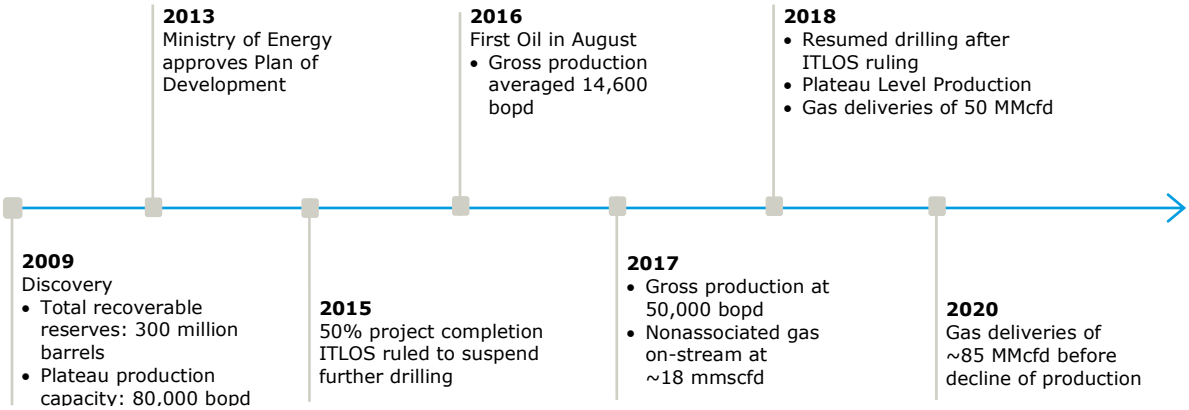



Figure I.4 illustrates the timeline of events in the development of the TEN field, from discovery to forecast, including estimated production levels.

**Figure I.4: TEN Timeline Overview**




*Source:* Composed based on information from Tullow Oil 2016; Tullow Oil 2017; World Bank 2015; World Bank 2009.
*Note:* bopd = barrels of oil per day; MMcfd = million cubic feet per day; mmscfd = million standard cubic feet per day; ITLOS = International Tribunal of the Law of the Sea.
*Production levels and statuses are past or future estimations.

The TEN Field was discovered in 2009, with estimated total recoverable reserves of about 300 million barrels and an estimated plateau production capacity of about 80,000 bopd (World Bank 2015c). In 2013, the Ministry of Energy approved the *Plan of Development*. which initiated a quick development of the field. Soon after, all seismic work was completed. (Tullow Oil 2017b, Tullow Oil 2016)

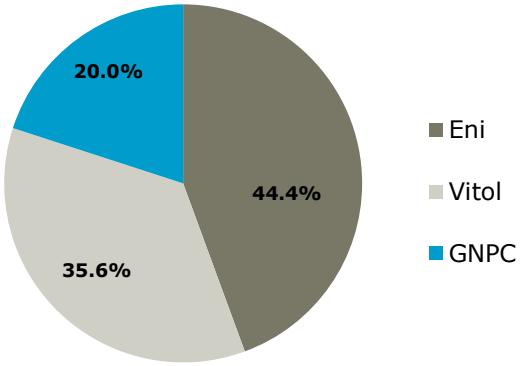
In January 2015, 50 percent project completion had been reached as 11 wells had been drilled and the FPSO vessel set-up was progressing (Tullow Oil 2016). In April 2015, the International Tribunal of the Law of the Sea (ITLOS) ruled in a maritime boundary dispute between Ghana and Côte d'Ivoire. Herein, Ghana made the case that the maritime boundary had been informally agreed on for a long time, even being manifested in Côte d'Ivoire's own maps. Ghana maintains that Côte d'Ivoire wants to benefit from TEN's reserves. Côte d'Ivoire, on the other hand, argues that Ghana violated its sovereignty when taking up drilling in the area. While this initial ruling does not affect the exploitation of previous drilling, additional drilling activities were to be suspended and provisional measures applied until the final decision in late 2017. (Tullow Oil 2017b, World Bank 2015b)

In August 2016, "first oil" was achieved on time and on budget, three years after the government approved the Plan of Development, and the gross annualized working interest production averaged 14,600 bopd (net: 6,900 bopd) (Tullow Oil 2017b, Tullow Oil 2017c). This milestone enabled the commissioning of further infrastructure for oil production, gas compression/injection, and water injection. A 24-hour flow test of the FPSO showed an average rate of over 80,000 bopd capacity in January 2017. Moreover, further tests supported initial reserve expectations for Ntomme and Enyenra. However, the need to manage pressure in the Enyenra reservoir and the outstanding ITLOS ruling require a prudent and sustainable handling of the existing 11 wells. This leads to an initial gross production of about 50,000 bopd (net 23,600 bopd), with the aim of reaching plateau production within the year (Tullow Oil 2017b). Moreover, nonassociated gas is expected to come on-stream, forecast at about 18 mmscfd (World Bank 2015c). In 2018, after the ITLOS ruling and resumed drilling, plateau level production is likely and gas deliveries are expected to supply 50 MMcfd (Tullow Oil 2017c, World Bank 2015b). Until 2020, the gas production is expected to reach 85 MMcfd, with a decline in volumes soon after (World Bank 2013, World Bank 2015b).

Sankofa Field

The whole OCTP block has the same project sponsors and shares, with Eni Ghana being the operator of the complex. The current participating interests are shown in figure I.5.

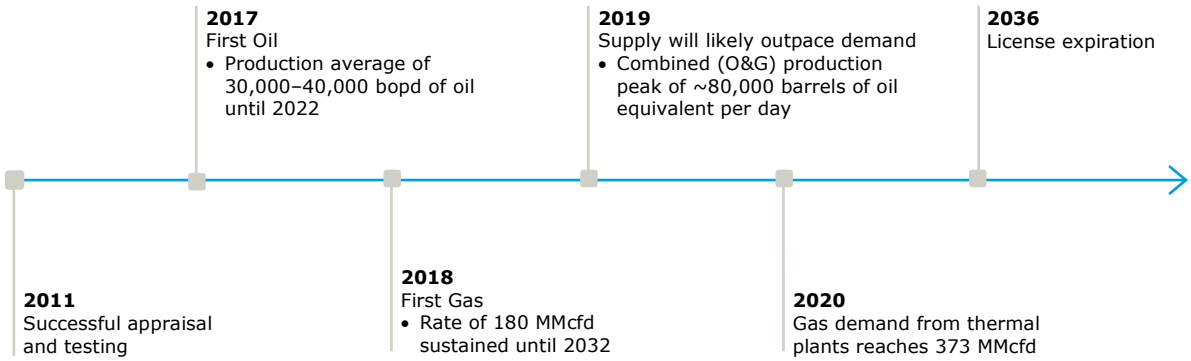
**Figure I.5: Participating Interests in the OCTP Block**




*Source:* World Bank 2015b

Figure I.6 illustrates the timeline of events in the development of the Sankofa field, from discovery to forecast, including estimated production levels.

**Figure I.6: Sankofa Timeline Overview**




*Source:* Eni 2016; World Bank 2015
*Production levels and statuses are past or future estimations.

In 2011, Eni successfully appraised and tested the Sankofa Field, leading to a development in two phases, with oil production preceding the gas production. Expected first oil is scheduled for 2017, with the following production to average at 30,000–40,000 bopd of oil until 2022 (Eni 2016, World Bank 2015b). First gas is expected in 2018 with a rate of 180 MMcfd, which should also be sustained for the next 14 years (World Bank 2015b). Until 2020, Sankofa's gas is planned to be delivered to the GNGC pipeline via Sanzule and then shipped to Takoradi, where it is commingled with gas from Jubilee and TEN (World Bank 2015b).

Between 2018 and 2019, the rapid gas supply is likely to outpace the demand at the point of supply, Takoradi. To leverage this supply and keep the other projects running as well, the connection between the GNGC pipeline and the West African Gas Pipeline (WAGP) becomes crucial. Then, the excess gas could be delivered to Eastern Ghana, where deficits will continue to persist (World Bank 2015b). In 2019, the combined oil and gas production is expected to

peak at about 80,000 barrels of oil equivalent per day (Eni 2016). Gas demand from current and planned thermal plants is estimated to reach 373 MMcfd in 2020 (World Bank 2015b).

After 2020, Ghana's Jubilee and TEN fields are expected to experience a significant drop in gas production, thus increasing Sankofa's importance. To ensure supply when the other fields stop production, the timely development of Sankofa is crucial. It should be in production for almost two decades thereafter, as the plateau period is set 14 years after start of production and the license does not expire before 2036 (World Bank 2015b).

*Abandonment and Decommissioning*

According to the Petroleum (Exploration and Production) Act 919 (2016), following the termination of operations, contractors must restore affected areas and remove all causes of damage or danger to the environment (table I.1). Contractors are required to provide a reclamation plan together with the Environmental Impact Statement (EIS) provided in the development phase, which will be applied during decommissioning (Ghana Environmental Assessment Regulations [LI 1652 1999]).

In addition, the contractor forms a reclamation security agreement and makes a security deposit with the Environmental Protection Agency (EPA) to account for possible damages (CMS Cameron McKenna LLP 2016).

**Table I.1 Activities Required by the upstream Oil and Gas upstream sector**

| Exploration | Development | Operation | Decommissioning |
|---|---|---|---|
| ▪ Exploration, seismic surveying, and data interpretation services<br>▪ Drilling services<br>▪ Rig provision<br>▪ Well heads, completion equipment<br>▪ Engineering and design services<br>▪ IT services<br>▪ Freight forwarding, transport, logistics<br>▪ Recruitment, manpower supply services<br>▪ Legal services<br>▪ Financial services<br>▪ Environmental services<br>▪ Hospitality, catering services | ▪ Engineering and design services<br>▪ Construction, fabrication and installation (platform, pipelines, flow lines, storage tanks, well heads)<br>▪ Civil works<br>▪ Welding<br>▪ Freight forwarding, transport, logistics<br>▪ Recruitment, manpower supply services<br>▪ Legal services<br>▪ Financial services<br>▪ IT services<br>▪ Environmental services<br>▪ Hospitality, catering services | ▪ Production enhancement services<br>▪ Inspection and maintenance services<br>▪ Reservoir management services<br>▪ Construction services<br>▪ Lifting services<br>▪ Freight forwarding, transport, logistics<br>▪ IT services<br>▪ Recruitment, manpower supply services<br>▪ Legal services<br>▪ Financial services<br>▪ Environmental services<br>▪ Hospitality, catering services | ▪ Engineering services<br>▪ Deconstruction<br>▪ Material disposal<br>▪ Legal services<br>▪ Financial services<br>▪ IT services<br>▪ Environmental services<br>▪ Hospitality, catering services |

*Source:* VIS Analysis (Primary & Secondary research)

## Midstream

*Gas Processing*

Ghana's natural gas processing plant, Atuabo Gas Plant, is located at Atuabo in the Nzemaland of the Western Region of Ghana. As noted in the Ghana Gas Master Plan (GMP), it was the completion of this onshore infrastructure, notably the processing plant at Atuabo and a pipeline from Atuabo to Aboadze, that enabled domestic gas has reached the market.

The Atuabo Gas Plant is operated by the Ghana National Gas Company (GNGC) as part of the Western Corridor Gas Infrastructure Development Project (WCGIDP), which was completed in 2014 and started commercial operations in 2015. The plant has a design capacity to process 150 mmscfd of raw gas into lean gas and NGLs (LPG and Condensate).[1] However, it has been reported that it has operated below its design capacity since operations begun (Sedjie 2015).

Apart from contributing natural gas to the national energy mix, the Atuabo plant's output includes 180,000 metric tons of LPG for domestic use, corresponding to 70 percent of the national annual requirement of 240,000 tons, 46,000 tons of Condensate, and 150,000 tons of Isopentane, reducing the import requirements for these products.[2]

Gas processing is a fundamental part of the natural gas value chain, as it produces higher value products and ensures that these products are of the quality required for their safe transport and use.

*Gas Transportation and Storage*

The Bulk Oil Storage and Transportation Company (BOST) is licensed by the Ghana Energy Commission to be the sole national transporter of natural gas, under the Natural Gas Transmission Utility License granted in 2012.

BOST maintains a network of storage tanks across Ghana, in the following locations: Accra Plains, Mami-Water, Akosombo, Kumasi, Buipe, and Bolgataga Depots.

*Gas Transmission Network*

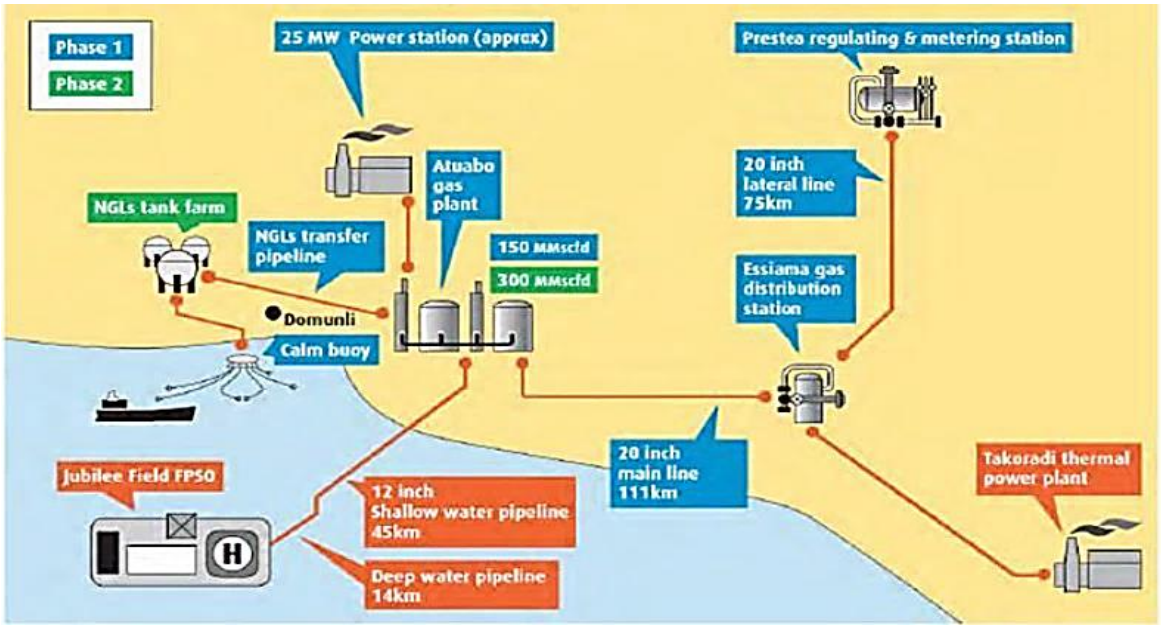
The existing gas transmission network in Ghana comprises components of the Western Corridor Gas Infrastructure Development Project (WCGIDP), and the West African Gas Pipeline (WAGP).

WCGIDP includes the following components, in addition to the Atuabo Gas Processing plant (Ghana Gas Master plan 2016):

- *Jubilee-Atuabo offshore gas gathering pipeline:* a 12-inch diameter, 59 kilometers offshore pipeline that brings raw gas from the Jubilee oil and gas fields' FPSO to the Atuabo Gas Processing Plant. Completed in 2013, it is owned and operated by the GNGC.
- *Atuabo-Aboadze onshore transmission pipeline:* a 20-inch diameter, 110 kilometers onshore gas transmission pipeline that brings lean sales gas from Atuabo to power plants at Aboadze. Completed in 2013, it is owned and operated by the GNGC.
- *Associated gas infrastructure for metering and distribution:* this includes an initial station at Atuabo, a distribution station at Essiama (the start of the branch line to Prestea), and a regulating and metering station at Takoradi.
- *Essiama-Prestea lateral pipeline, regulating and metering station:* a 20-inch diameter, 75 kilometer long lateral pipeline connecting the Essiama Distribution Station to the Prestea Regulating and Metering Station.

Figure I.7 illustrates the components of the WCGIP.

**Figure I.7: Components of the Western Corridor Gas Infrastructure Project**




*Source: Ghana Gas Master Plan*, figure 42.

The Onshore Gas Transmission Pipeline and Metering Systems have been designated as the National Integrated Gas Infrastructure System (NGITS).

*WAGP*

The WAGP links Nigeria's Itoki Natural Gas Export Terminal with Benin, Ghana, and Togo. In Ghana, the pipeline reaches Takoradi and Tema. 85 percent of the gas transported is intended for power generation and the remainder for industrial application. The Volta River Authority's Takoradi Thermal Power Plant is one of West African Gas Pipeline Company's (WAPCo) foundation customers (WAPCo n.d.).

BOST is reported to be actively looking to expand the pipeline network in Ghana in the near term, with priority given to Southern Ghana to even out supply and demand imbalances between the East and West of Ghana (Bost 2016). The Ghana GMP makes medium and long-term recommendations for the development of the gas sector, including strategic gas infrastructure such as a coastal east-west pipeline, an LNG terminal in Tema, and reverse flow arrangements with WAGP.

*Gas Distribution Network*

The gas distribution network, as planned in the Energy Commission's Gas Transmission and Distribution Plan 2007, put forward developing a gas distribution network between Tema and Accra to serve major industrial and commercial off takers, based on sufficient gas supplies from WAGP. The Ghana GMP makes infrastructure recommendations based on the 2007 plan, WAGP supply assumptions, and demand forecasts by region.

Gas pipelines, as well as a reverse flow on WAGP and an LNG regasification terminal located offshore in Tema, are considered part of this gas distribution network. A project agreement has recently been made between GNGC and a Chinese multinational for the construction of a 278-kilometer onshore gas pipeline from Aboadze in the Western Region to Tema in the Greater Accra Region, intended to serve industrial users. Multiple gas distribution stations are planned

to be constructed between the two major load centers of Takoradi and Greater Accra (Nyavor 2017).

**Downstream**

*Oil Refining*

In Ghana, oil refining takes place at the Tema Oil Refinery (TOR), which started operation in 1963, refining crude oil imported from Nigeria. TOR's current refining capacity is 45,000 bpd. Running at full capacity, the refinery would be able to satisfy approximately 50–60 percent of the national demand for petroleum products (Oxford 2013). The remainder of the demand is met by imports undertaken by bulk distribution companies.

Of the new oil and gas industry developments in Ghana, TOR has received 1,000,000 barrels from TEN to date. The Jubilee field has not provided any crude for refinement, as its production is bound by off takers overseas for the first 15.5 years of production (Beard 2011). Crude oil from TEN would strengthen the incentive for TOR's expansion: the intention is for TOR's refining capacity to increase to 60,000 bpd in the short term and to 100,000 bpd in the long term (primary research).

The refinery consists of a hydro skimming unit, established in 1963, and a residual fluid catalytic cracker (RFCC) unit, established in 2002. The finished products derived from processing at the hydro skimming unit are liquefied petroleum gas (LPG), light and heavy gasoline, domestic and aviation turbine (Jet A1), kerosene, gas oil (diesel), and low sulphur fuel oil. The products obtained from the RFCC are LPG, motor gasoline, light cycle oil, heavy cycle oil, and clarified oil. The refinery is connected to an oil jetty and the single point mooring and conventional buoy mooring at the Port of Tema by pipelines of various diameters for importing of crude oil and refined petroleum products.

The refinery capacity was limited to 28,000 bpd due to an explosion in January 2017 (Bloomberg 2017); at the time of writing, it was completely shut down for repairs. Refining capacity keeps deteriorating primarily due to aging equipment and funding constraints for maintenance. This indicates limited linkages between the upstream and the downstream subsectors in Ghana.

In general, oil refining is an advanced and highly specialized business. Refineries tend to focus on different niche products that have very different setups, and it is common for refineries to exchange products to match their specialized setup. In the case of Ghana, one refinery will not be able to supply all refined products consumed in the country even if it operates at full capacity. Plans for a second refinery (by South African New Alpha Refinery-Ghana), with earmarked capacity to process 200,000 barrels of crude per day and expansion potential, seem to have stalled compared to the initial anticipated timeframe (Ghana Web 2011).

*Gas-Related Activities*

The gas sector was only recently established in Ghana and no competitive gas market exists. Main uses of gas are typically residential/commercial, industrial, and power generation. Wholesale gas contracts are held between Nigerian gas suppliers and the Volta River Authority for power generation. There is a relatively mature market for LPG in Ghana, and LPG has been promoted by the government of Ghana since 1986 (Ghana Gas Master Plan 2016) as a method of dealing with problems arising from using fuel wood and charcoal as a domestic source of energy. The LPG policy, first introduced in 1992, is in the process of being reviewed at the time of writing, with a focus on the nationwide marketing and safe distribution of LPG (Yire 2017).

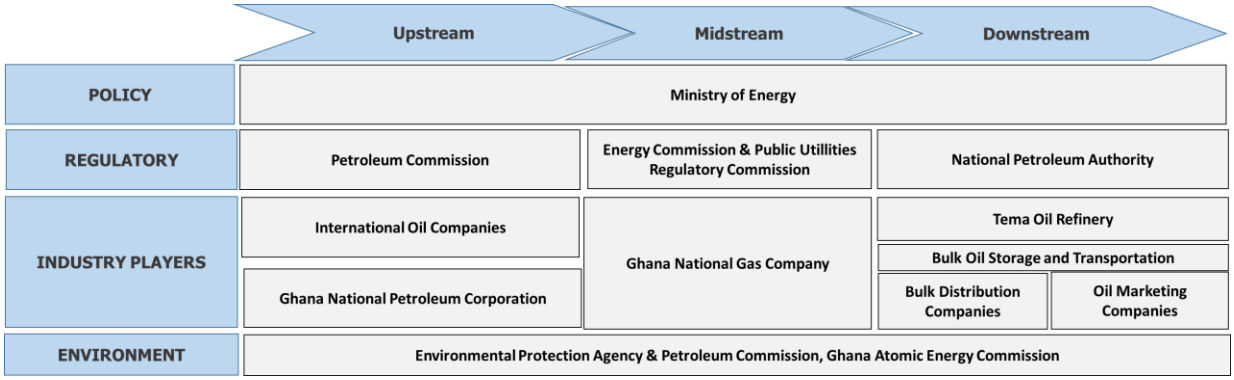
A network of LPG filling stations exists, mostly in and around Accra. Despite the policy and governmental support, however, LPG has not seen the take-up rate expected in domestic use (Acharibasam and Apatinga 2014); it has, however, increasingly been used in transport and commercial sectors over recent years.

The LPG sector in Ghana is a subsector of the petroleum area with both public and private sector participants. Key players in Ghana's LPG subsector are the Ministry of Energy, the National Petroleum Authority, the Tema Oil Refinery, LPG marketing companies and oil marketing companies, transporters and retailers, cylinder manufacturing companies, manufacturers of LPG accessories and importers of LPG cylinders and tanks (Edjekumhene, Atta-Owusu, and Ampong 2007).

## Part 2: Stakeholders along the Value Chain

Figure I.8 shows the stakeholders involved across the oil and gas value chain in Ghana in its different segments (upstream, midstream, downstream) and under defined activity categories (e.g. policy, regulatory). A further description of each of these stakeholders will try to answer the question of "who undertakes the above analyzed activities in the oil and gas industry in Ghana" adding to the whole picture of the Ghanaian oil and gas value chain.

**Figure I.8: Stakeholder Structure along the Value Chain**




### Upstream

*Policy*

Ministry of Energy (MoE) was enhanced in 2014 by the development of its new divisions:

1. Ministry of Petroleum
2. Ministry of Power

MoE forms the policies and regulations for the effective management of the hydrocarbons in Ghana. Its specific functions can be summarized as follows:

- Formation of strategies and programs through a national petroleum policy in accordance with the government's oil and gas development agenda
- Provision of policies concerning the exploration, development, and production of the oil and gas resources in Ghana
- Participation in the negotiations for drafting the Petroleum Agreement with the IOCs
- Participation in every segment of the oil and gas value chain, ensuring reliable supply of affordable energy services to fulfil the domestic demand as well as exports
- Monitoring of sector institutions to make sure that they have the capacities for effective planning, coordination and programs delivery[3]

*Regulation*

Petroleum Commission (PC)

The PC was established in 2011 (Act 821 of the Parliament),[4] and it is the upstream regulator responsible for the promotion of well-executed and cost-efficient activities in the upstream

subsector to optimize the utilization of the oil and gas resources for the benefit of the country and its local community. Specifically, the PC:

1. Has the mandate to receive and evaluate applications from companies interested in conducting upstream activities and to decide whether to issue relevant permits
2. Monitors whether the stakeholders involved in the upstream activities comply with national laws and regulations
3. Is responsible for receiving and storing petroleum data and has the obligation to publish an annual report on petroleum resources and activities in the official government gazette (Reporting O&G 2016)

*Industry Players*

Ghana National Petroleum Corporation (GNPC)

GNPC is Ghana's national oil company (NOC). Its mandate, established under Law 64 (2(1)), is to undertake the exploration, development, production, and disposal of petroleum resources. Its specific objectives include overseeing the exploration and development of petroleum resources in Ghana to ensure sustainability and maximum benefit for Ghana's people; achieving effective technology transfer; and capacity building in the context of oil and gas exploration and production.

GNPC participates in the operational phase of petroleum resource exploitation together with IOCs on behalf of Ghana. The regulatory framework for the contractual relationship between GNPC, the state, and prospective investors in upstream operations is prescribed within the Petroleum [Exploration and Production] Law of 1984. Among its key functions, GNPC:

1. Has the right of entry into activities in any open space in Ghana to undertake exploration.
2. Is partner in all petroleum agreements in Ghana.
3. Is the national gas sector aggregator in Ghana.

GNPC Subsidiaries

GNPC has set up three operational subsidiaries with capacity building, technology transfer, and commercial interest in mind. These were established to enable the NOC to achieve its target of becoming a world-class operator within 15 years and assuming a leadership role in Ghana's oil and gas industry. These subsidiaries include:

1. Ghana Trading Company (TRADCO)
2. GNPC-Technip Engineering Services (GTES)
3. GNPC Exploration and Production Company (Explorco)

GTES is an engineering company that is the result of a partnership between GNPC and the Technip Group. It provides engineering services throughout the spectrum of oil and gas sector activities, from feasibility studies to construction supervision. Its goal is to increase national participation and develop the transfer of knowledge and technology to Ghana (Technip 2016).

GNPC has utilized Explorco, which is a limited liability company, to take on calculated commercial risk in selected blocks offshore Ghana (currently six blocks) and build operating capability through joint operating company models with world-class operators active in Ghana's upstream subsector. In addition, Explorco has acquired 33.3 percent of GNPC Operating Services Company Limited (GOSCO), the operator in two Petroleum Agreements (Offshore South West Tano and East Keta).[5]

International Oil Companies (IOCs)

IOCs are granted rights to explore oil and gas resources by signing petroleum agreements (PAs) with Ghana's national oil company, GNPC. As outlined before, IOCs participating in the development of the three fields in focus are included in table I.2.

**Table I.2: IOCs in Ghana: Jubilee, TEN, and Sankofa**

| Jubilee field | TEN field | Sankofa field |
|---|---|---|
| **Tullow oil and gas Ghana**<br>**Kosmos Energy**<br>**Anadarko Petroleum Corporation**<br>**Sabre oil and gas**<br>**EO Group**[a] | Tullow Oil and gas Ghana<br>Kosmos Energy<br>Anadarko Petroleum Corporation<br>PetroSA | Eni Ghana<br>Vitol Ghana[b] |

*Sources:* [a]Kastnin 2011; [b]Offshore Technology n.d.

## Midstream

*Regulation*

Energy Commission and Public Utilities Regulatory Commission

The EC is a statutory body that acts as a commercial regulator in the midstream subsector of the oil and gas industry. Its mission involves the regulation and management of energy resources of Ghana in such a way that affordability, security of supply, efficiency in production, and delivery are achieved and the social and economic well-being of Ghanaians is promoted. The EC's mandate includes providing the legal, regulatory, and supervisory framework for all providers of energy in the country by granting licenses for the transmission, wholesale, supply, distribution and sale of electricity and natural gas, and associated activities.[6]

The Public Utilities Regulatory Commission (PURC) was set up as a multisectoral regulator in 1997 to regulate the provision of utility services in the water and electricity sectors. The entities regulated include the Volta River Authority (VRA), Northern Electricity Distribution Company (a subsidiary company of VRA), the Ghana Grid Company, the Electricity Company of Ghana, as well as Ghana Water Company Ltd. Among its duties, PURC sets the transmission tariff and aggregated prices for gas, as well as the pricing elements related to the Bui Power Authority.[7]

*Industry players*

Ghana National Petroleum Corporation (GNPC)

Specifically, in relation to gas, GNPC is the buyer of gas at the wellhead and owner of the gas until its sold to distributors and large customers. It has been engaged in gas sales negotiations on the domestic market with the aim of achieving the best price for gas at the domestic market.

Ghana National Gas Company (GNGC)

GNGC (also referred to as Ghana Gas) was established in 2011 with the mandate of gathering, processing, transporting, and wholesaling gas. Initially the roles of GNPC and GNGC in the context of gas would appear to have unclear boundaries. Exploration, production, and gas aggregation are the responsibility of GNPC, while GNGC owns and operates the Western Corridor Gas Infrastructure, the Atuabo Gas Processing Plant, and the offshore gathering pipeline and the Atuabo-Aboadze gas pipeline, and it has the responsibility to develop the downstream distribution system, initially for industrial gas customers. This is anticipated to be streamlined,

as Ghana Gas has recently become a subsidiary of GNPC. A goal is to achieve more efficient and effective coordination and facilitation of infrastructure investment and financing.

## Downstream

*Regulation*

National Petroleum Authority (NPA)

The NPA is the downstream regulator, established in 2005 (National Petroleum Authority Act 691) with the responsibility to monitor the activities in the downstream, making sure that the industry is competitive, efficient, profitable, and fair to the consumers (Acheampong et al. 2015). Act 691 introduced a gradual deregulation of the downstream industry. The reforms were set in motion in 2015 and included the following:

1. Removing limits on new entries in the downstream sector
2. Removing limits on the imports
3. Eliminating price controls

*Industry players*

Bulk Oil Storage and Transportation (BOST)

Until 2005, only TOR was in charge of the bulk oil distribution. The GNPC and BOST got involved in the distribution of oil (Adombila 2016). GNPC and BOST behave as importers of crude oil and petroleum products. BOST is currently responsible for distributing refined petroleum products throughout the country. Its main shareholder is the government of Ghana and its responsibility is to develop a network of storage tanks, pipelines, and other transportation infrastructure necessary for the distribution of the petroleum products.

BOST has a network of pipelines from Accra to Akosombo and from Buipe and Bolgatanga. The total distance of these pipelines is 370 kilometers. The available storage facilities together with their capacities are provided in table I.3:

**Table I.3: Available Oil Storage Capacities by Region**

| Depots | Gasoline | Gasoil | Kero | Total |
|---|---|---|---|---|
| **Accra Plains** | 101,250 | 109,25 | | 210,500 |
| **Kumasi** | 34,000 | 43,000 | 10000 | 87,000 |
| **Buipe** | 13,500 | 37,600 | | 51,100 |
| **Bolgatanga** | 12,500 | 35,000 | | 47,500 |
| **Akosombo** | 5,000 | 7,000 | | 12,000 |
| **Mami-Water** | 5,000 | 12,500 | | 17,500 |
| **Total** | 171,250 | 244,350 | | 425,600 |

*Source:* BOST. "Key Responsibilities." www.bost.com.gh/key-responsibilities.

Bulk Distribution Companies (BDCs) and Oil Marketing Companies (OMCs)

Following the liberalization of the downstream subsector, new private companies entered the market to enhance competition and reduce end user prices for consumers (Adombila 2016). BDCs are licensed to import crude oil and refined petroleum products and are responsible for their storage and distribution to OMCs in the downstream subsector (Oxford 2016).

OMCs receive finalized products from the BDCs and sell them to the final consumers, either directly or through service stations and heating-oil distributors.

## Part 3: Local Content Regulation

The discovery of natural resources and the potential for their exploitation must translate into direct and indirect benefits for local economies in terms of increased employment and economic activity. The types of benefits and degree of impact on a country's economy and society can vary significantly and depend on several political, economic, and social factors (Senoo et al. 2015). More specifically, in the context of the oil and gas sector, which is characterized by its capital, knowledge, and technology intensiveness, the employability of local companies and people in developing economies seems to be limited at best.

Governments in resource-rich countries adopt "local content" policies to facilitate links between the economy and the oil and gas industry and promote local economic development through local participation in the extraction sector. While the intent of local content policies is generally understood, there is no common definition of who a "local" supplier is or which is the exact content defined as local. There are many different definitions for local content. They include, for example, the World Bank's "domestic preference" qualification, which is measured as the percentage of local ownership (SEGOM 2012), and the Trinidad and Tobago Local Content and Local Participation Policy (2004), which defines local content in terms of ownership, control, and financing by its citizens.

The common element among different definitions is that local content is the "local value-added," and it refers to the purchases of goods and services from national suppliers and the employment of the local workforce.

The Petroleum (Local Content and Local Participation) Regulations (L.I. 2204) were enacted in November 2013 and enforced in February 2014 (Senoo et al. 2015). The LC Regulation's main objective is to avoid what is known as the "resource curse"[8] and to promote the utilization of local economic factors (people, goods, and services) by the IOCs active in the upstream sector, with the target to instigate economic growth, reduce poverty, and contribute to the general prosperity of the citizens of Ghana (see box I.1).

**Box I.1: Local Content**
LC in Ghana is defined as "the quantum or percentage of locally produced materials, personnel, financing, goods, and services rendered in the petroleum industry value chain and which can be measured in monetary terms."
Source: Local Content Plan Template published by the Petroleum Commission Ghana

The term *indigenous Ghanaian company* refers to a company that

- has at least 50 percent of its equity owned by a citizen of Ghana and
- has Ghanaian citizens holding at least 80 percent of executive and senior management positions and 100 percent of nonmanagerial and other positions (CCSI 2014).

### Local Goods and Services Procurement

LI2204 prescribes the relevant minimum local procurement conditions for the participation of foreign IOCs and contractors in oil and gas activities in the country. These broadly involve the following:

- Preference is to be given to indigenous Ghanaian companies in the award of contracts. Moreover, a company tendering for a contract is to have at least 5 percent participation of equity by an indigenous Ghanaian company to have the right to enter a petroleum agreement. That condition can be altered by the minister of energy and petroleum if 5 percent equity participation cannot be fulfilled.
- A nonindigenous Ghanaian company can supply goods and services to the Ghanaian oil and gas sector provided it incorporates a joint venture with an indigenous company with an equity participation of at least 10 percent.
- A contractor is obliged to provide a Local Content Plan before undertaking activities in the industry, and it must include details of their joint venture with an indigenous Ghanaian company and the contractor's strategy regarding transferring knowledge and technology to that company (Act 4 (1,2,3,6,7)). The Local Content Plan must be also provided annually by the contractor, subcontractor, licensee, or other allied entity (Act 7 (2b)). Quarterly forecast reports of the goods and services contracts awarded to locals and their values must be submitted by the contractor, subcontractor, licensee, or other allied entity (Act 14).

The target for local goods and services procurement to be attained from the date of effectiveness of license or petroleum agreement are presented in table I.4.

**Table I.4: Local Goods and Services Procurement Requirements in Ghana's Oil and Gas Sector**

| Local goods and services procurement requirements | Start | 5 years | 10 years |
|---|---|---|---|
| | 10% | 50% | 60%–90% |

*Source:* Petroleum (Local Content and Local Participation) Regulations, 2013 (LI 2204).

The Petroleum (Local Content and Local Participation) Regulations (2013) also outline in detail specific target levels for types of goods and services (pipeline systems, pumping services, and so forth).

Companies' insurance must be obtained from Ghanaian firms. If an exception is sought, it should be proven that the Ghanaian capacity was exhausted and/or could not have been utilized (Act 27,28).

In addition, LI2204 states that legal and financial services must be procured from Ghanaian enterprises. However, financial services could be exempted if not satisfactory. Contractors, subcontractors, licensees, or other allied entities are to submit a subplan reporting the services that they used (Acts 29,30, 31,32).

Finally, companies operating in Ghana are obliged to maintain a bank account in an indigenous Ghanaian bank (100 percent Ghanaian or with the Ghanaian share the majority) (Act 33).

Quarterly forecast reports of the goods and services contracts awarded to locals and their values must be submitted by the contractor, subcontractor, licensee, or other allied entity (Act 14).

### Local Employment and Training

Companies are required to submit an Employment and Training subplan as part of their Local Content plan, per Act 3 (a). This plan must include:

- A forecast of the hiring skills needed, the Ghanaian's skills shortages, the training needs, as well as their expected costs
- The timing in which the companies will be able to provide working opportunities to Ghanaians
- The expected training efforts that will be undertaken

Moreover, the contractor, subcontractor, licensee or other allied entity must provide a quarterly report which will include the employment and training activities undertaken during that period, a comparative analysis of the Employment and Training Subplan to monitor their compliance, and a statement of the number of the new Ghanaians employees and their job descriptions. Where a lack of expertise by Ghanaians leads to unsuccessful local employment, companies must ensure in their statements that every possible effort (for example, training) was made to avoid that (Act 17 (1,2,3,5)).

The relevant targets for local employment for each of the categories defined in the LCR to be attained from the date of effectiveness of license or petroleum agreement are presented in table I.5.

**Table I.5: Local Employment Requirements in Ghana's Oil and Gas Sector**

| Local employment requirements | Start | 5 years | 10 years |
|---|---|---|---|
| **Management staff** | 30% | 50%–60% | 70%–80% |
| **Technical core staff** | 20% | 50%–60% | 70%–80% |
| **Other staff** | 80% | 90% | 100% |

*Source:* Senoo and Armah 2015.

### Technology Transfer, Research, and Development

Companies involved in the industry are required to provide a technology transfer subplan alongside their Local Content Plan, according to Act 24. This plan must outline efforts aiming at the transfer of technology to indigenous Ghanaian companies and people. Companies are also required to have a research and development subplan with a timeline of three to five years. This plan should include the research and development initiatives that companies would like to establish during that period as well as the expected cost of these actions. The latter plan shall be updated yearly and submitted to the PC for approval.

### Monitoring LCR's Implementation

The Local Content Regulation established a Local Content Committee responsible for monitoring the implementation of the regulation (Act 5).

Its responsibilities can be summarized as follows:

- Prepare guidelines, desired targets and formats for the Local Content Plans
- Make recommendations to the PC regarding the local content's successful implementation
- Initiate public education
- Submit quarterly reports to the PC

Its general, the Local Content Committee's mandate is to ensure the continuous growth of the local content in the industry. However, the committee does not itself accept or reject the Local Content Plans. It makes recommendations for accepting or rejecting them to the PC, which has this power.

The PC further responsibilities are as follows:

- The development, in cooperation with the National Development Planning Commission, relevant ministries, agencies, and other stakeholders, of a national policy on technology transfer within the petroleum industry and publish it in the gazette. The technology transfer subplans that companies are required to submit must be in accordance to this National Policy (Act 23).

- The establishment of a "Common Qualification System" for verifying the contractors' capabilities and capacities, evaluating the local content applications, monitoring the local content performance and provide feedback, and ranking the companies according to their local content compliance (Act 37,38).
- Publication on its website of any information concerning the LC Regulation (Act 39 (4)).
- Proving education to the contractors on the philosophy and the requirements of the LC Regulation to make sure they comply with it (Act 40).

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# APPENDIX J: BACK-TO-OFFICE MISSION REPORT

## Introduction

The upcoming study seeks to answer the following overarching question:

***What are the outcomes of the IFC-supported oil and gas investments in Ghana derived from (i) the increased market share of gas-fired power generation, and (ii) the development of the oil and gas value chains?***

A field mission was conducted from July 10th through July 21st for fact finding and information validation, as prescribed in paragraph 2.3.4. of the study approach paper. Consequently, the team charged with the mission conducted over 20 interviews in three Ghanaian cities with main sector stakeholders, including public sector, private sector, NGOs, and Think-Tanks. The team charged with the mission (the team) was integrated by Brigid Commey (IFC), Marian E. Wiredu (IFC), George Seferiades (VIS), and Miguel Angel Rebolledo Dellepiane (IFC). The team recognizes and values the support received from the IFC Country Office led by Ronke Amoni Ogunsulire, and from the IFC Portfolio manager Shane Rory Clancy. In the WBG Accra office, Elam Muchira, Marina Diagou, Issahaku Budali, and Shinya Nishimura contributed significantly to the mission with information and their professional views.

## Mission Outline

Under this mandate, the team held 21 interviews in Accra, Tema, and Takoradi.

## Data Collection

The team collected qualitative information from these interviews and documented it in minutes of meetings. The team also requested quantitative data from several interviewees (table J.1). As of now, Invest in Africa and Tullow Oil have partially provided the requested data. E-mail and phone reminders will be sent in the two coming weeks with the support from the IFC Ghana office.

**Table J.1: List of Interviewees with Follow-up Requests for Quantitative Data**

| Organization name | Interviewee | Date when data was requested |
|---|---|---|
| **Ghana National Gas Company (GNGC)** | Dr. Ben K. D. Asante, Acting Chief Executive Officer | 13/07/2017 |
| **Tullow Oil** | Emmanuel Benjamin, Environment Team Lead<br>Tesa Ayernor, Commercial Affairs | 18/7/2017 |
| **Vitol Group** | John-Paul Stalder, Investments Director | Received through IFCs, AMRs |
| **Volta River Authority** | Gertrude N. Komson,<br>Manager, Corporate Communications | 11/7/2017 |
| **Invest in Africa** | Emefa Fiadzoe, Support Executive, Business Linkage Programme<br>Sam Brandful, Ghana Manager | 12/7/2017 |
| **Rigworld** | Stephen Adarkwah, Finance Manager | 12/7/2017 |
| **Amaja Oilfield Ltd** | Emmanuel Yaw Buabeng, General Manager<br>Abigail Nana Ama Kwofie, HR Manager<br>Frederick Ocloo, Finance Manager | 13/7/2017 |
| **Eni Ghana Exploration and Production Ltd** | Baluri Kassim Bukari, Local Content & Sustainability Manager | 14/7/2017 |
| **Ghana Statistical Service** | Anthony Amuzu, Deputy Government Statistician<br>Edward Asuo-Afram, Director of Economic Studies<br>Another 8 officials | 15/7/2017 |
| **Petroleum Commission** | Kwaku Boateng, Director Special Services<br>Francis B. Ackah, Director, Resource Management & Operations<br>Samuel Frimpong Topen, Consultant<br>Harriet H.S.A. Fabyan, Macro economist<br>Agatha Enos Armah, Contracts & Procurement Administrator | 20/7/2017 |
| **Ghana National Petroleum Corporation (GNPC)** | Albert Akowuah, Principal, Corporate Strategy & New Business<br>Nana Kwaku Otchere, Corporate Strategy & New Business | 20/7/2017 |

The National Chamber of Commerce (Accra), the Western Region Chamber of Commerce (Takoradi), the Sekondi- Takoradi Chamber of Commerce & Industry, and Pyxera Group (Takoradi) kindly reviewed for completion and adequacy the list of SMEs engaged in the sector that the consultant had put together. The objective of this list is to survey in September these SMEs to understand patterns of job creation and integration in the oil and gas supply chains.

**Initial Observations**

General Observations:

- The oil and gas sector is still young and the developments in the value sector has been below the original (possibly exaggerated) expectations
- However, there has been progress and an evolution in terms of goods and services in the sector by local companies from 2009 to date.

- Adherence to the standards required by international companies has been particularly challenging for local companies (goods and services)
- The overall market in its current state is small to support the development of a fully specialized local upstream oil and gas industry. There is a need for significant upscale in exploration and development before the market size could support the emergence of a more comprehensive industry.
- The local content regulation has been successful overall in promoting the local element for development, both in terms of people skills as well as in terms of sector companies' development

Specific Observations:

- The international companies have put forward several initiatives for the development of local SMEs and job skills. However, not all local companies can benefit given that the required investment needed to either build capacity to meet demand or to certify is difficult to be met.
- Access to credit is difficult for SMEs. The problem is on one hand that the interest rates are close to the range of 35 percent to 40 percent and on the other that most SMEs collateralized assets are of low quality for commercial banks to accept
- Given the very recent history of the upstream sector in the country, only a small number of individuals had the capacities / skills required for technical and upper management positions in the industry given the required standards. A small number of Ghanaian expatriates from Canada and the Gulf area with related experience did return to Ghana
- The Ghanaian market is small to be able to support the development of a specialized oil and gas goods industry without ability to export its products and expertise. This is compounded by the lack of regional focus on local content regulation (i.e., Economic Community of West African States).
- The Local content regulation as overall perceived as successful in supporting the development of local skills / capacities and SMEs growth contrasted to the situation prior to its ratification (2013)

**Next Steps**

- Expedite the reception of the quantitative data requested.
- Complete the SMEs survey design and coordinate with IFC Ghana and potentially with Pyxera for its execution and detailed target audiences.
- Analyze the qualitative and quantitative information gathered during and after mission

**Risks**

- Quantitative data availability.
- Low response rate in the SMEs survey.

# APPENDIX K: SME SURVEY DESIGN

## Introduction

The survey's objective was to collect information from small and medium enterprises (SMEs) operating in the oil and gas supply chain. The results complement the other two methodological building blocks as described in Chapter 3: Methodology.
The survey provides insight regarding local content participation from SMEs interested in entering the oil and gas value chains.

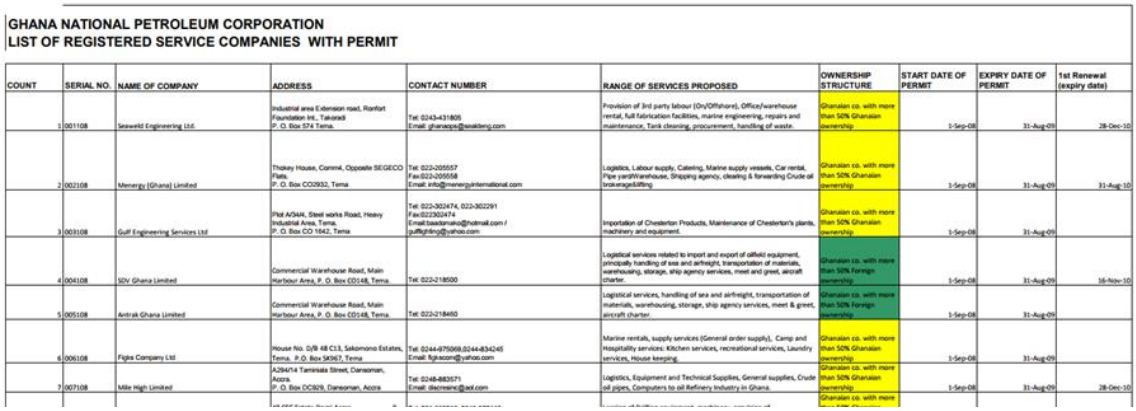
## Selection of Population

The target population for the survey comprised all the companies that supply goods and services to the oil and gas industry (upstream, midstream and downstream) to examine the impact of the three developments (Jubilee, TEN, Sankofa) on the local value chains. We primarily focused on SMEs given that most of companies in Ghana fall under this category. However, we did not exclude a handful of companies servicing the sector that can be considered large according to the adopted SME definition (companies that employ over 100 people).

To obtain a full list representing the potential total population of companies serving the sector, we combined different sets of companies from various sources, as it was not possible to find a single source for the entire target population. We subsequently shared the final list with the National Chamber of Commerce and Takoradi Chamber of Commerce to verify that we have captured the population of the companies interested in participating in the sector's value chain. Relevant sources include:

1. Service companies registered with the Ghana National Petroleum Corporation (Reporting O&G n.d.). This list includes 403 companies servicing the sector. See figure K.1.

**Figure K.1: Registered Service Companies with Permit in the Ghana National Petroleum Corporation**



GHANA NATIONAL PETROLEUM CORPORATION
LIST OF REGISTERED SERVICE COMPANIES WITH PERMIT

| COUNT | SERIAL NO. | NAME OF COMPANY | ADDRESS | CONTACT NUMBER | RANGE OF SERVICES PROPOSED | OWNERSHIP STRUCTURE | START DATE OF PERMIT | EXPIRY DATE OF PERMIT | 1st Renewal (expiry date) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 001108 | Seaweld Engineering Ltd. | Industrial area Extension road, Ronfort Foundation Int., Takoradi P. O. Box ST4 Tema. | Tel: 0243-431808 Email: ghanaops@seaweld.com | Provision of 3rd party labour (On/Offshore), Office/warehouse rental, full fabrication facilities, marine engineering, repairs and maintenance, Tank cleaning, procurement, handling of waste. | Ghanaian co. with more than 50% Ghanaian ownership | 1-Sep-08 | 31-Aug-09 | 28-Dec-10 |
| 2 | 002108 | Menergy (Ghana) Limited | Thokey House, Comme, Opposite SEGECO Flats, P. O. Box CO3932, Tema | Tel: 022-205557 Fax:022-205558 Email: info@menergyinternational.com | Logistics, Labour supply, Catering, Marine supply vessels, Car rental, Pipe yard/Warehouse, Shipping agency, clearing & forwarding Crude oil brokerage/bilting | Ghanaian co. with more than 50% Ghanaian ownership | 1-Sep-08 | 31-Aug-09 | 31-Aug-10 |
| 3 | 003108 | Gulf Engineering Services Ltd | Plot A/344, Steel works Road, Heavy Industrial Area, Tema, P. O. Box CO 1642, Tema | Tel: 022-302474, 022-302291 Fax:022302474 Email:baadomako@hotmail.com / gulfighting@yahoo.com | Importation of Chesterton Products, Maintenance of Chesterton's plants, machinery and equipment. | Ghanaian co. with more than 50% Ghanaian ownership | 1-Sep-08 | 31-Aug-09 | |
| 4 | 004108 | SDV Ghana Limited | Commercial Warehouse Road, Main Harbour Area, P. O. Box CO148, Tema. | Tel: 022-218500 | Logistical services related to import and export of oilfield equipment, principally handling of sea and airfreight, transportation of materials, warehousing, storage, ship agency services, meet and greet, aircraft charter. | Ghanaian co. with more than 50% Foreign ownership | 1-Sep-08 | 31-Aug-09 | 16-Nov-10 |
| 5 | 005108 | Antrak Ghana Limited | Commercial Warehouse Road, Main Harbour Area, P. O. Box CO148, Tema. | Tel: 022-218460 | Logistical services, handling of sea and airfreight, transportation of materials, warehousing, storage, ship agency services, meet & greet, aircraft charter. | Ghanaian co. with more than 50% Foreign ownership | 1-Sep-08 | 31-Aug-09 | |
| 6 | 006108 | Figks Company Ltd | House No. D/8 48 C13, Sakomono Estates, Tema. P.O. Box SK967, Tema | Tel: 0244-675069,0244-834245 Email: figkscon@yahoo.com | Marine rentals, supply services (General order supply), Camp and Hospitality services: Kitchen services, recreational services, Laundry services, House keeping. | Ghanaian co. with more than 50% Ghanaian ownership | 1-Sep-08 | 31-Aug-09 | |
| 7 | 007108 | Mile High Limited | A294/14 Taminasa Street, Dansoman, Accra. P. O. Box DC829, Dansoman, Accra | Tel: 0248-883571 Email: dscreenc@aol.com | Logistics, Equipment and Technical Supplies, General supplies, Crude oil pipes, Computers to oil Refinery Industry in Ghana. | Ghanaian co. with more than 50% Ghanaian ownership | 1-Sep-08 | 31-Aug-09 | 28-Dec-10 |
| | | | | | | Ghanaian co. with more | | | |

2. Companies registered in the Ghana Supply Chain Development Program, kindly provided by the program. This includes 124 companies.
3. Bulk distribution companies (BDCs) and oil marketing companies (OMCs) servicing the downstream segment, obtained from the National Petroleum Authority (NPA, the regulator of the downstream sector). This amounted to 116 companies. See figure K.2.

**Figure K.2: BDCs Listed by NPA**

| | NAME OF COMPANY | MD | REGISTERED OFFICE | POSTAL ADDRESS | CERTIFICATE OF INCORPORATION | TELEPHONE NO | EMAIL |
|---|---|---|---|---|---|---|---|
| 1 | ALFAPETRO GHANA LIMITED | ERIC FORSON | NO. 57 KINSHASA STREET, EAST LEGON, ACCRA | P.O. BOX CT 2975 CANTOMENTS | CA-71,918 | 0302-544-949/ 0209303907/02444224372 | temaoffice@alfapetro.com |
| 2 | BATTOP ENERGY LIMITED | BEN ATSU-AGBOMANYI | DEVTRACO ESTATE JUNCTION, NEW DAWHENYA OFF TEMA-AFLAO ROAD | P.O. BOX 1636, TEMA | CS539932014 | +233 244875652/+233 202112944 | benagbomanyi@gmail.com |
| 3 | BLUE OCEAN INVESTMENTS LIMITED | HENRY OSEI | WING A 7TH FLOOR, ONE AIRPORT SQUARE, AIRPORT CITY | P.O. BOX AN 1046, ACCRA | CA-43,376 | 0302-746266 | henry.osei@blueocean.com.gh |
| 4 | CHASE PETROLEUM GHANA LIMITED | DAN AMOAH | CH GROUP BUILDING, BLOCK NO. 60, RANGOON LANE, 5TH FLOOR, CANTOMENTS-ACCRA | P.O.BOX AN 8743, ACCRA NORTH | 87,805 | 0302-215700-3 | info@chaseghana.com |
| 5 | CIRRUS OIL SERVICES LIMITED | IVY APEA OWUSU | PLOT NO. 25/3/5 TRUSTY FOOD HEAVY INDUSTRIAL AREA TEMA | P.O.BOX KIA 30414, AIRPORT-ACCRA | CA-34600 | 0302781522/4/5 0544335045 | info@cirrusoilgh.com |
| 6 | DEEN PETROLEUM GHANA LIMITED | INSAH IDDRISU | C612/14 TETTEH KWEI STREET, DZORWULU | P. O. Box KA 30368 Airport Accra-Ghana | CA-58,857 | 0209560000 | info@deenpetroleum.com |
| | DOME ENERGY | JAMES | Plot No. 124, Near Islamic | | | | |

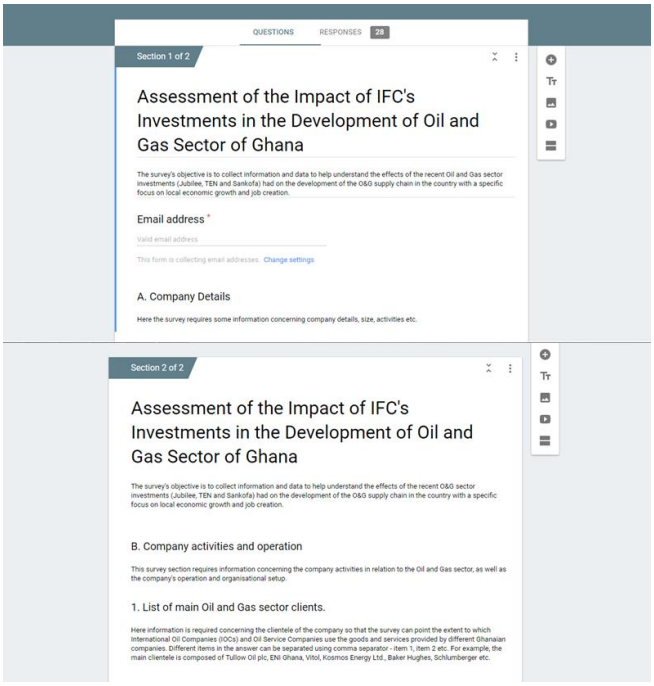
*Source:* National Petroleum Authority. "Petroleum Service Providers." http://www.npa.gov.gh/service-providers

An important finding through this process was that, according to the Petroleum Commission (PC), and the National and Takoradi Chambers of Commerce, a significant number of the registered companies may not be operational. This was probably because, following their initial interest, companies were discouraged by the high standards demanded by the IOCs, as required by the nature of the industry. Neither the PC nor the two Chambers of Commerce keep precise information about the SMEs that actively pursue suppliers' contracts. However, there was consensus on that "it is only a fraction of the registered companies that serve the sector."

**Selection of the Surveying Method**

The surveying method chosen was contingent on the project budget and material capacities. With this in mind, and given that contact details of the final list of the target population were available, we chose to conduct an email-based survey. We designed a simple and brief online questionnaire with automatic back-end analytics figure K.3). The questionnaire comprised two parts: part A, which requested general information concerning company details, size, activities, and so forth, and part B, the main part of the questionnaire, which aimed at collecting information concerning the company's activities in relation to the oil and gas sector, the company's operation and organizational setup, as well as companies' view on the effectiveness of the Local Content Regulation and its impact on facilitating participation of the local supplier base in the sector.

**Figure K.3: Parts A and B of Survey**




The questionnaire was dispatched individually to every recipient in the final list on September 18, 2017 with the initial deadline set on October 3, allowing the respondents two weeks to submit their answers. A first reminder email was sent on Monday, September 25, and the final reminder was sent o of October 2, allowing for a small deadline extension until the October 9. The survey follows in its entirety.

**The Survey**

# Assessment of the Impact of IFC's Investments in the Development of oil and gas Sector of Ghana

The survey's objective is to collect information and data to help understand the effects of the recent sector investments in the Jubilee, TEN and Sankofa fields on the development of the sector’s supply chain in the country, with a specific focus on local economic growth and job creation

# A. Company Details

Here the survey requires some information concerning company details, size, activities etc.

1. **Please write your name and your position within the company.**

2. **What is the company's name?**

Here you are required to put the name of the company/Legal Entity.

3. **Please state your address and contact details of the company (telephone, email, website).**

Please differentiate information items with a comma separator. For example: +233312345678, company@company.com, www.company.com

4. **What is the date of establishment of the company?**

Example: December 15, 2012

5. **Date of registration with the Petroleum Commission if the company is registered:**

Example: December 15, 2012

6. **What is the company size?** Mark only one oval.

- Small (equal to or less than 19 employees)
- Medium (between 20 and 99 employees)
- Large (100 employees and above)

7. **What is the ownership status of the company?**

Here it is required to understand whether the company is 100% Ghanaian owned or a Ghanaian owned with at least 51% Ghanaian participation in the company equity or a Joint Venture with a foreign company but still with Ghanaian participation (at least 10% Ghanaian participation in the company equity) or a subsidiary by a foreign company with less than

10% Ghanaian participation in the company equity or finally a foreign company with NO Ghanaian participation at all (0% Ghanaian participation). Mark only one oval.

- 100% Ghanaian ownership
- At least 51% Ghanaian owned
- Less than 51% but more than 10% Ghanaian owned
- Less than 10% Ghanaian owned
- 0% Ghanaian participation

**8. Oil and gas sector segment the company serves:**

The oil and gas sector involves the upstream, midstream and downstream sub-sectors. In the upstream segment, the main activities undertaken are exploration, development of the field, production and decommissioning. The midstream involves gas processing into useful fuel and its transportation, as well as, the transportation of the crude oil from the field to the refinery for further treatment. The downstream sector usually includes the refinement process of the oil into its products as well as its distribution and marketing to the final consumers. As you can see bellow, we have included an option ''other'' where you can specify if the company does not serve any of the oil and gas segments or serves more than one segment e.g. ''both midstream and downstream''. Mark only one oval.

- Upstream
- Midstream
- Downstream
- Other: _____

**9. What is the main activity type of the company?**

This question serves at classifying the types of activity in which the company engaged. You can choose more than one categories, as appropriate. In case where none of the categories listed adequately describes the company's main activities then please choose option ''other'' from the list and describe the company's main activity(ies). Check all that apply.

- Engineering/Construction
- Logistics/Transportation
- Recruitment services/ Manpower supply
- Hospitality/Catering
- Equipment Provider
- Consulting/Insurance/Legal services
- Other:

# B. Company activities and operation

This survey section requires information concerning the company activities in relation to the oil and gas sector, as well as the company's operation and organizational setup.

1. **List of main oil and gas sector clients.**

Here information is required concerning the clientele of the company so that the survey can point the extent to which International Oil Companies (IOCs) and Oil Service Companies use the goods and services provided by different Ghanaian companies. Different items in the answer can be separated using comma separator - item 1, item 2 etc. For example, the main clientele is composed of Tullow Oil plc, Eni Ghana, Vitol, Kosmos Energy Ltd., Baker Hughes, Schlumberger etc.

2. **What are the specific goods/services the company provides in the oil and gas sector?**

Again, different items in the answer can be separated using comma separator - item 1, item 2 etc. For example, the main services provided by the company in the oil and gas sector are catering services, transport services, logistics etc.

3. **How has the proportion of goods/services provided to the oil and gas sector by the company changed overtime?**

Here information is required that will help in understanding the impact and its evolution overtime of the three oil and gas sector investments had in Ghana's supply chain. This could be measured in terms of the portion of the annual turnover that can be attributed to contracts with the oil and gas sector. For example, if in the financial year 2009 the company had revenues of $100,000 and $20,000 were from oil and gas sector contracts, then the answer for 2009 is 20% and you tick the third box for the respective year "between 11% and 30%". Mark only one oval per row.

| | Does not serve the oil and gas sector | less than 10% | between 11% and 30% | between 31% and 50% | between 51% and 70% | between 71% and 90% | Over 91% | 100% |
|---|---|---|---|---|---|---|---|---|
| 2007 | | | | | | | | |
| 2008 | | | | | | | | |
| 2009 | | | | | | | | |
| 2010 | | | | | | | | |
| 2011 | | | | | | | | |
| 2012 | | | | | | | | |
| 2013 | | | | | | | | |
| 2014 | | | | | | | | |
| 2015 | | | | | | | | |
| 2016 | | | | | | | | |
| 2017 | | | | | | | | |

**4. What is the company's view in terms of increasing/decreasing business as a proportion of goods/services provided to the oil and gas sector in the future?**

Here the survey wants to establish the qualitative view of the company in terms of future business growth as a result of more business from the oil and gas sector. From 1 to 5 please choose based on how much you think doing business with the oil and gas sector in the country will change for your company. 1 = future reduction in oil and gas-related business, 2 = no increase, no decrease, 3 = some (minor) increase in oil and gas-related business, 4 = moderate increase in oil and gas related business and 5 = significant increase in oil and gas-related business for your company. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Future reduction in O&G-related business | | | | | | Significant increase in O&G-related business for your company |

**5. What has been the annual turnover of the company from year 2007 until 2017?**

Here the survey requires information to assess the potential growth or not of the company as a result of increased business in the oil and gas sector. For example, if the total sales in 2007 were $50,000 and in 2008 were $100,000, you type the year followed by the turnover as shown: 2007-$50,000; 2008-$100,000; 2009-$...;...2017-...

**6. What is the proportion of the total value of goods and services provided by the company to the oil and gas sector that stays in Ghana?**

Here the survey requires information in order to assess what portion of the value generated actually stays in the country and what portion is used to import goods and/or know how/services from abroad. For example, a company that offered in 2009 engineering and subsea services to the oil and gas sector and charges $100,000 for the service but at the same time pays $80,000 to a Norwegian company for chartering the vessel, this would mean that 20% of the value of goods and/or services provided stayed in Ghana in 2009. Therefore, for 2009 the third box "Between 11% and 30%" should be chosen. Mark only one oval per row.

| | 0% | Less than 10% | Between 11% and 30% | Between 31% and 50% | Between 51% and 70% | Between 71% and 90% | Over 91% | 100% |
|---|---|---|---|---|---|---|---|---|
| 2007 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2008 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2009 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2010 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2011 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2012 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2013 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2014 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2015 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2016 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2017 | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

**7. What is the employees number in the company from 2007 to 2017?**

Here the survey requires information concerning the workforce evolution in time. The expected reply should be a time series of employment in the company with the [years - number of employees] separated by comma. For example: 2007 - 120, 2008 - 126, 2009 - 127, 2010 - 135, ..., 2017 - 200

**8. What is the company's view in terms of increasing / decreasing its workforce in the mid to long term?**

Here the survey wants to establish the qualitative view of the company in terms of future employment growth. From 1 to 5 please choose based on how much [or not] you think the company employment will increase. 1 signifies a future reduction in workforce, 2 signifies stable evolution [no increase, no decrease], 3 signifies some increase in the number of company employees, 4 and 5 signify a stronger increase in the number of company employees, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| future reduction in the number of employees | ◯ | ◯ | ◯ | ◯ | ◯ | future strong increase in the number of employees |

**9. According to your opinion how have the developments (Jubilee, TEN, Sankofa) in the oil and gas sector influenced the number of employees in the company?**

Here the survey requires information so as to observe the impact (if any) of these developments to employment in the oil and gas supply chain in Ghana. It is important to separate any increase or decrease of the number of employees from other activities that the company might be participating in. For example, if the company had 50 employees in 2009 and today it has 100 employees, this increase of 50 employees should be considered only if it is linked to company activities related to the oil and gas sector servicing. From 1 to 5 please choose based on how significant those developments have been to the increase of workforce in the company. 1 signifies no influence at all, 2 and 3 signify little or some influence, 4 and 5 signify significant and very significant influence, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| No influence | ◯ | ◯ | ◯ | ◯ | ◯ | Very significant influence |

**10. How many of the company employees are Ghanaian nationals from 2007 to 2017?**

Here the survey requires information concerning the Ghanaian workforce evolution in time. The expected reply should be a time series of Ghanaians employed in the company with the [years number of employees] separated by comma. For example: 2007 - 100, 2008 - 106, 2009 - 107, 2010 - 115, ..., 2017 - 190

**11. Employment status of the company's workforce.**

Here the survey requires information on the type of employment terms of the company's Ghanaian workforce. For example, if the company has 100 employees and 10 of them are working full time with a temporary status and 3 of them are foreign and 7 Ghanaian that means that 30% of the full time with a temporary status positions are held by foreign and 70% of the full time and temporary status positions are held by Ghanaian. Therefore, for this situation you choose for the first row ''full time and temporary status/Ghanaian'' the 5th box. Mark only one oval per row.

| | 0% | less than 10% | Between 11% and 30% | Between 31% and 50% | Between 51% and 70% | Between 71% and 90% | Over 91% | 100% |
|---|---|---|---|---|---|---|---|---|
| Full Time and Temporary Status/Ghanaian | | | | | | | | |
| Part Time and Temporary Status/Ghanaian | | | | | | | | |
| Full Time and Permanent Status/Ghanaian | | | | | | | | |
| Part Time and Permanent Status/Ghanaian | | | | | | | | |

**12. Company employees job position classification.**

Here the survey requires information concerning the different job positions of the company and the proportions of these positions filled by Ghanaian. For example, if the company has 100 employees and 10 of them are in management positions and 3 of them are foreign and 7 Ghanaian that means that 30% of management positions are held by foreign and 70% of management positions are held by Ghanaian. Therefore, for this situation you choose for the first row ''management positions/Ghanaian'' the 5th box. Mark only one oval per row.

| | 0% | Less than 10% | Between 11% and 30% | Between 31% and 50% | Between 51% and 70% | Between 71% and 90% | Over 91% | 100% |
|---|---|---|---|---|---|---|---|---|
| Management Positions/Ghanaian | | | | | | | | |
| Technical positions/Ghanaian | | | | | | | | |
| Other skilled positions/Ghanaian | | | | | | | | |
| Unskilled positions/Ghanaian | | | | | | | | |

**13. In your view and on a scale of 1 – 5 with 5 being the most effective, how effective has the Local Content regulation been in support of the oil and gas Ghanaian supply chain development?**

From 1 to 5 please choose based on how effective Local Content regulation has been in supporting the oil and gas Ghanaian supply chain development. 1 signifies not effective at all, 2 and 3 signify little or some effect, 4 and 5 signify significant and very significant effect, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not effective | ◯ | ◯ | ◯ | ◯ | ◯ | Very effective |

**14. Which are the main barriers the company encountered/still encounters in servicing the oil and gas sector in Ghana?**

Here the survey tries to identify the main barriers a company in Ghana encounters in the effort to enter the oil and gas industry. Please choose all the barriers the company faces from bellow (you can choose more than one option) and click on the other option if you want to add any other challenge the company encounters and we haven't included in the list. Check all that apply.

- ☐ Access to finance
- ☐ Skills shortages
- ☐ Standards and certifications demanded by the sector
- ☐ Lack of information access
- ☐ Other: _____

**15. On a scale of 1 – 5 with 5 being the most positive, how have the investments in the Oil and gas sector influenced the training/education programs that the company has organised or participated in?**

From 1 to 5 please choose based on the level of influence the three developments (Jubilee, TEN, Sankofa) had in introducing new training/education programs. 1 signifies no influence at all, 2 and 3 signify little or some influence, 4 and 5 signify significant and very significant influence, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not influenced | ◯ | ◯ | ◯ | ◯ | ◯ | Very positively influenced |

**16. On a scale of 1 – 5 with 5 being the most positive, how has the introduction of the Local Content regulation influenced the training/education programs that the company has organised or participated in?**

From 1 to 5 please choose based on the level of influence the Local Content regulation had in introducing new training/education programs. 1 signifies no influence at all, 2 and 3 signify little or some influence, 4 and 5 signify significant and very significant influence, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not influenced | ◯ | ◯ | ◯ | ◯ | ◯ | Very positively influenced |

**17. List the training or education programs your company has organised or participated in (if any).**

You can separate different items in the answer using comma separator—item1, item2, etc. For example, some of the educational programs your company could have organised or participated in are SCD program, Invest in Africa etc.

**18. On a scale of 1 – 5 with 5 being the most positive, would you say that Jubilee, TEN and Sankofa developments have been instrumental for your company to invest in new equipment and/or technology?**

From 1 to 5 please choose based on the level of influence the three developments (Jubilee, TEN, Sankofa) had in introducing new equipment/technologies in the company. 1 signifies no influence at all, 2 and 3 signify little or some influence, 4 and 5 signify significant and very significant influence, respectively. Mark only one oval.

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Not at all instrumental | ◯ | ◯ | ◯ | ◯ | ◯ | Yes, very instrumental |

**19. What percentage of the investments made by the company in new equipment and/or technology can be attributed to the developments in the oil and gas sector**

Here the survey requires information in order to assess what portion of the investment made in new equipment and/or technology can be attributed to the developments (Jubilee, TEN, Sankofa) in the oil and gas sector. For example, if the company invested in 2009 the amount of $100,000 in total but $20,000 for new equipment and/or technology in order to service the oil and gas sector, then tick for the year 2009 the third box ''between 11% and 30%" representing the answer 20% of the investment in 2009 can be attributed to the developments (Jubilee, TEN, Sankofa) in the oil and gas sector.

Mark only one oval per row.

| | 0% | Less than 10% | Between 11% and 30% | Between 31% and 50% | Between 51% and 70% | Between 71% and 90% | Over 91% | 100% |
|---|---|---|---|---|---|---|---|---|
| 2007 | | | | | | | | |
| 2008 | | | | | | | | |
| 2009 | | | | | | | | |
| 2010 | | | | | | | | |
| 2011 | | | | | | | | |
| 2012 | | | | | | | | |
| 2013 | | | | | | | | |
| 2014 | | | | | | | | |
| 2015 | | | | | | | | |
| 2016 | | | | | | | | |
| 2017 | | | | | | | | |

20. **Please add any additional comments you may have regarding the effect that the Local Content regulation and the investments in Jubilee, TEN, Sankofa had in the Ghanaian economy in terms of local economic growth and job creation.**

**Thank you for your participation and support in this important IFC study!**

**Survey Responses Statistics**

Valid companies:[1]

1. Registered companies listed with Ghana National Petroleum Corporation: 171
2. With the Ghana Supply Chain Development Programme :112
3. With the National Petroleum Authority: 90

The total potentially valid population was 373, representing 59 percent of the total listed number of companies. (The initial number of registered companies was 631, but 258 did not have a working email domain anymore. and a small fraction of them did not operate in the oil and gas sector). From this pool of companies (373), we can conservatively assume that half actually actively operate (given what we were told by the PC and the different chambers), making the final valid population at 186.

We received in total 29 responses, leading us to a conservatively estimated 15.5 percent random responses.

## References

Reporting O&G. n.d. "Ghana National Petroleum Corporation List of Registered Service Companies with Permit." http://www.reportingoilandgas.org/wp-content/uploads/oil_and_gas_companies_registered_in_ghana2.pdf.

## Notes

[1] Nonvalid are companies from the list that did not have a functioning email address and companies that responded but stated that they do not serve the O&G sector

# APPENDIX L: LOCALLY PROVIDED GOODS AND SERVICES TO THE UPSTREAM OIL AND GAS SECTOR

**Table J.1: Types of Local Supplier Activities and Main Services, 2016**

| Type of activity | Main services | Most representative segment served |
|---|---|---|
| **Civil engineering and construction, metal fabrication and welding** | Real estate development and civil works; general and industrial, offshore and onshore welding and fabrication; aluminum glass works; wiring services; piping works; rust control and protection; steel renewal/refurbishing of ships; structural and plate works; plant maintenance; architecture and civil engineering; furniture and fixtures; steel structures; installation, assembling and dismantling; training; modular buildings; plant and equipment hiring; experienced labor hiring | Upstream, indirect (to oilfield service providers) |
| **Chemical engineering and industrial chemicals** | Corrosion protection; equipment installation; repair and maintenance; vessel services; waste management | Upstream, indirect |
| **Electrical engineering** | Air-conditioning system services; equipment installation; repairs and maintenance | Upstream, direct and indirect |
| **Mechanical engineering and automobile** | Imports and sales; services and deliveries; vehicle rental services; truck services; metal fabrication services; welding services | Upstream, direct and indirect |
| **Transport and logistics** | Fleet management; personnel recruitment; meet and greet; customs clearance; freight forwarding; ship brokerage; general port agency; cargo handling; storage and warehousing; ground transport and haulage; vessel hiring and chartering; logistics management; safe bond car terminal | Upstream, direct and indirect |
| **Lifting, equipment hire, and supplies** | Personal protective equipment (PPE) provision; supply, installation and maintenance of oilfield equipment and spare parts; provision of computer accessories and consumables; installation of communication equipment; labor supply; accommodation and office rental services; protocol and other logistical services (pipe yard, warehousing and bulk storage); crane and equipment hire | Upstream, direct and indirect |
| **Fire equipment installations and PPE provisions, office uniforms** | Suppression systems; fire alarm systems; fire detection and control equipment; office uniforms; pest and rodent control services; recruitment services; offshore catering; diving services; crew manning; supply of cleaning products; ICT equipment; uniforms, safety, PPE, hardware (tools, paints, nails, small parts); equipment and supplies (electrical, piping, pumps, valves, fittings, insulation, vessel, instruments) | Upstream, direct and indirect |

| | | |
|---|---|---|
| **Catering and hospitality** | Onshore and offshore hospitality services; catering facilities design; staff recruitment; training; catering and related services | Upstream, indirect |
| **Cleaning and janitorial services** | Gardening and landscaping; janitorial services; waste management | Upstream, indirect |
| **Graphics and design** | Graphic design and print; corporate souvenirs; car branding; crystal awards/plaques; safety/PPE signs; outdoor advertising; laser cutting and engraving; t-shirt printing; secretarial services; general printing; embroidery, sewing, textiles | Upstream, direct and indirect |
| **Waste management** | Oil spill response; oil waste management; soil remediation; incineration; waste treatment services | Upstream, direct and indirect |
| **Woodcraft** | Furniture manufacturing; laser engraving; gifts and souvenirs | Upstream, direct and indirect |
| **Research, security, IT, and inspections** | Security and protection services; sale and rental of office equipment and accessories; equipment installation, repair and maintenance; ICT servicing and maintenance; courier services | Upstream, indirect |

# APPENDIX M: JOB-TRAINING AND SME CAPACITY-BUILDING INITIATIVES

## Initiatives Focused on Job-Related Training

*Jubilee Technical Training Centre (JTTC)*

The center was established in collaboration with Takoradi Polytechnic. It is a public-private initiative by the Jubilee Partners (Tullow Oil, Anadarko Petroleum Corporation, and others) with a target to build the capacity in skills required by the oil and gas sector. It offers a National Vocational Qualification level 2 certification in processing, instrumentation, electrical and mechanical engineering, as well as National Examination Board in Occupational Safety and Health (NEBOSH) Health, Safety, and Environment (HSE) certification.

*Ghana Upstream Sector Internship Program (GUSIP)*

GUSIP is a Petroleum Commission (PC) initiative that aims to equip Ghanaian graduates and young professionals with the skills required by the upstream oil and gas sector. GUSIP trains young graduates directly in the oil and gas working environment. After series of screening exercises the PC short-listed 150 graduates for the training; 43 of them have already started their training in international oil companies (IOCs) and service providers.

*Ghana Upstream Sector Technical, Vocational and Apprenticeship Program (GUSTVAP)*

GUSTVAP is another PC initiative that aims to assist selected technical and vocational institutes in areas such as certifications and accreditation, equip the institution's workshops, and build instructors' capacity.

*Oil and Gas Safety Training Centre in the Regional Maritime University (RMU)*

The Oil and Gas Safety Training Centre was established in the RMU in collaboration with Sibrima Maritime Training Centre, which has years of maritime training experience in the industry. The Oil and Gas Safety Training Centre offers mandatory safety qualifications for the offshore oil and gas industry: the Basic Offshore Safety Induction and Emergency Training (BOSIET) and Tropical-BOSIET.

*Tullow Group Scholarship Scheme (TGSS)*

TGSS aims at "bridging the skills gaps in the oil and gas sector" in Ghana (Tullow Oil 2015). The scholarship targets students willing to undertake postgraduate degrees related to the oil and gas sector in leading universities in the United Kingdom, Ireland and France. It also provides scholarships for domestic universities and supports the domestic education system.

*Ghana National Petroleum Corporation (GNPC) Scholarship*

The GNPC is offering limited scholarships, through the GNPC Foundation, to Ghanaian students for degree courses (undergraduate, masters, and doctoral engineering in oil- and gas-related areas) at public tertiary institutions in Ghana: universities, technical universities, and polytechnics.

*Sponsors for Educational Opportunity (SEO) Africa, partnership with Kosmos Energy*

SEO selects university students form African countries and offers them on-the-ground training in the oil and gas industry. Kosmos has been partnered with SEO since 2014 and has introduced a total of 12 interns.

**Initiatives Focused on SME Capacity Building**

Several public and private initiatives and institutions have been set up for the support of small and medium enterprises and the promotion of entrepreneurship in Ghana, some of which are specifically relevant to companies wishing to be involved in the country's oil and gas sector. IOCs operating in Ghana support these as well as implement their own programs to enable and facilitate local SMEs' participation in the sector. Beyond the typical corporate social responsibility reporting, these programs contribute to the development of local contractors and suppliers that deliver services to them, thus enabling IOCs to fulfil their local content obligations.

Major initiatives and organizations for the development of SMEs include the Association of Ghana Industries (AGI), the Enterprise Development Center (EDC), Invest in Africa (IIA), the National Board for Small-Scale Industries, and the Supply Chain Development Program (SCD), among others.

The EDC and SCD deserve more attention, because they often serve as the main entry point into the oil and gas industry for inexperienced SMEs:

- As of July 2014, six businesses that had completed the EDC training and been awarded contracts by IOCs and service companies.[1] Some of these had experience working with Ghana's shipping and mining industry; such companies tend to have a comparative advantage to new entrants (Ablo 2015).
- The SCD program has engaged with 250 companies to date. Currently, 100 companies are actively engaged and receive training every month. Seventy-two contracts ($18.5 million) were awarded to these companies during 2014–17.

*Association of Ghana Industries (AGI)[2]*

The AGI is a voluntary business association of over 1,200 businesses, established in 1957. Members come from small, medium, and large-scale manufacturing and services industries in agro-processing, agri-business, pharmaceuticals, electronics and electrical, telecommunications, information technology, utilities, services industries, transport, construction, textiles, garments and leather, banking, and advertising. It raises awareness about private sector constraints through advocacy, capacity building, and knowledge-sharing initiatives.

*Enterprise Development Centre (EDC)*

The EDC is a joint initiative of the Ministry of Energy, the Ministry of Trade and Industry and the Jubilee partners, established in Takoradi in 2013. It was established with a US$5 million budget to provide support to Ghanaian SMEs so they can position themselves to take advantage of opportunities in the oil and gas sector, promote collaboration among SMEs, and arrange third party support for SMEs where necessary. Among the services provided were business training, advisory services, and access to markets and information. It also acted as a focal point for coordination between SMEs and oil and gas companies, their contractors, and subcontractors.[3]

As of July 2014, six businesses that had completed the EDC training had been awarded contracts by IOCs and service companies. As noted, some of these had experience from working with Ghana's shipping and mining industry.

The EDC facility was to be operated for five years by the Jubilee Partners. The operation of EDC was suspended at the time of writing, but, according to GNPC, it will be transferred shortly to the PC.[4]

*Invest in Africa (IIA)[5]*

The IIA is a not-for-profit organization working across African economies, established in 2012 by Tullow Oil. Its global partners include Lonrho, EY (Ernst & Young), and Ecobank. It works in

partnership with private and public-sector companies to identify and address challenges of doing business in Africa. This is delivered through creating sustainable cross-sector partnerships, empowering local enterprise, supporting private-sector-led growth, and promoting the simplification of doing business in Africa. The organization has partnered with 84 businesses involved in the oil and gas sector in Ghana. Among specific actions are the following: IIA ran a two-year capacity-building program for SMEs, relating to long-term business planning and training on management techniques. IIA hosted a key tool for the business community, the African Partner Pool. This is an electronic platform where businesses' needs are matched with local suppliers. This cross-sector business community also serves the oil and gas sector.

*National Board for Small Scale Industries, Government of Ghana*[6]

The board works toward the creation of an enabling environment for the small-scale enterprise development and development of an enterprise culture in Ghana. It facilitates access to credit and business development services and promotes micro and small enterprise sector associations.

*Supply Chain Development Program (SCD)*

SCD was established in Takoradi in 2013, funded by USAID, and operated by PYXERA Global, which works with local SMEs to build their capacity and improve their competitiveness in the oil and gas sector supply chain (PYXERA 2016; 2017). Capacity building is delivered almost exclusively through Ghanaian consultants and trainers—business services providers (BSPs)—who have benefited from SCD training programs.

The SCD identifies technical areas of need via a gap analysis, which takes place at regular intervals. It entails interviewing stakeholders in the oil and gas sector to identify issues and key areas for capacity building and operational improvement in local suppliers. A bespoke training program is then developed based on the results of the gap analysis, which targets the following areas:

- HSE best practices and policy
- Procurement best practices and skills development
- Welding inspection and quality control
- Quality management systems
- Information technology

The SCD also organizes workshops and events to bring SMEs in contact with financial institutions and provide support to obtain industry-specific technical certifications. A key feature of the program is its focus on building the capacity of BSPs as well as SMEs with regular "train the trainers" initiatives to strengthen the long-term sustainability of the program after the SCD completes its activities.

Training was initially provided for free; two years later, a payment of 20 percent of the cost was introduced as a fee for trainees to participate. This ensured that trainees were engaged and had the sense of investing in new skills and knowledge.

**Supply Chain Development Program Gap Analysis, 2017**

The SCD's gap analysis for 2017 provides a snapshot of the training needs identified by stakeholders in the industry. See table M.1.

**Table M.1: Current Technical Areas of Need, SCD, 2017**

| | | | |
|---|---|---|---|
| **Strategic and/or business planning** | **83%** | **Standards and certifications** | **60%** |
| **Risk management and compliance** | 78% | Procurement | 60% |
| **Health, safety and environment** | 75% | Leadership | 55% |
| **Bid and proposal support** | 75% | Operations management | 55% |
| **Market research** | 68% | Financial planning and management | 53% |
| **Costing and pricing** | 68% | Technology and information management systems | 53% |
| **Quality management** | 68% | Supply chain development | 48% |
| **Networking skills and opportunities** | 68% | Taxation | 45% |
| **Access to finance** | 65% | Human resources | 40% |
| **Sales, marketing, and communications** | 63% | International accounting | 38% |
| **Information on procurement opportunities** | 63% | Other | 5% |

*Note:* Percentages represent the number of respondents indicating a specific training need out of the total respondent population.

## Other

In addition, there are other organizations that take part in capacity building, such as the Ghana National Chamber of Commerce and the Sekondi-Takoradi Chamber of Commerce, which focus on improving the business environment and building capacity for their members to participate in global value chains.

## References

Ablo, A. D. 2015. "Local Content and Participation in Ghana's Oil and Gas Industry: Can Enterprise Development Make a Difference?" *Extractive Industries and Society* 2:320–327.

PYXERA Global. 2016. "Ghana Supply Chain Development Program." Takoradi, Ghana: PYXERA. https://www.pyxeraglobal.org/wp-content/uploads/2016/01/SCD-Program-One-Pager-201506-v.5.pdf

PYXERA Global. 2017. "Ghana Supply Chain Development Program Recognized for Outstanding Achievements in Local Content." Washington, DC: PYXERA Global. https://www.pyxeraglobal.org/ghana-supply-chain-development-program-recognized-for-outstanding-achievements-in-local-content/.

Tullow Oil. 2015. "2015 Tullow Group Scholarship Scheme." London. Tullow Oil. https://www.tullowoil.com/media/case-studies/2015-tullow-group-scholarship-scheme.

## Notes

[1] The EDC was operational until 2016. However, the most recent data that could be retrieved were from 2014.

[2] Information from Association of Ghana Industries website, http://www.agighana.org/, accessed July 2017.

[3] Information from Ghana's Enterprise Development Center website, http://www.edcghana.org/ accessed July 2017.

[4] GNPC, primary research 2017.

[5] Information from Invest in Africa website, http://www.investinafrica.com/, accessed July 2017.

[6] Information from National Board for Small-Scale Industries website, http://www.nbssi.gov.gh/, accessed July 2017.

# APPENDIX N: THE GEM-E3-G MODEL

This appendix discusses in detail how the GEM-E3-G models firms' investment decisions, the Ghanaian energy system, infrastructure investment, and the Ghanaian debt profile. It also discusses the sources for the input-output table used.

### Stage 1: Modelling the Fields' Construction Phase

The GEM-E3-G models the firms' decision to invest $I_{i,r,t}$ (formula [1]) based on an endogenous component where entrepreneurs compare the rate of return on capital and of replacing capital $\frac{PK_{i,r,t}}{PINV_{i,r,t}\cdot(RLTLR_{r,t}+decl_{i,r,t-1})}$ and on an exogenous component ($stgr_{i,r,t}$ ). The construction of the oil and gas fields is then introduced exogenously in the investment function of the firms.

$$I_{i,r,t} = a0inv_{i,r,t}\cdot KAVC_{i,r,t} \cdot\left(\left(\frac{PK_{i,r,t}}{PINV_{i,r,t}\cdot\left(RLTLR_{r,t}+decl_{i,r,t-1}\right)}\right)^{a1inv_i}\cdot\left(1+stgr_{i,r,t}\right)-1+decl_{i,r,t-1}\right) \quad [1]$$

Where
$I_{i,r,t}$ is the investment of firm *i* in country *r* in time *t*
$a0inv_{i,r,t}$ is a scale calibration parameter
$KAVC_{i,r,t}$ is the capital stock of firm *i* in country *r* in time t
$PK_{i,r,t}$ is rate of return on capital of firm *i* in country *r* in time *t*
$PINV_{i,r,t}$ is the unit cost of investment of firm *i* in country *r* in time *t*
$RLTLR_{r,t}$ is the real interest rate in country *r* in time *t*
$decl_{i,r,t}$ is the depreciation rate of firm *i* in country *r* in time *t*
$a1inv_i$ is the speed of adjustment of capital stock of firm *i*
$stgr_{i,r,t}$ is the exogenously specified investment of firm *i* in country *r* in time *t*

Once the firms make the decision to invest, the model quantifies the demand for capital products (that is, the demand to sectors engaged in the construction) using an investment matrix (table N.1). This investment matrix is based on the gross fixed capital formation as available in the IO tables, and it is updated where necessary with information from external sources.

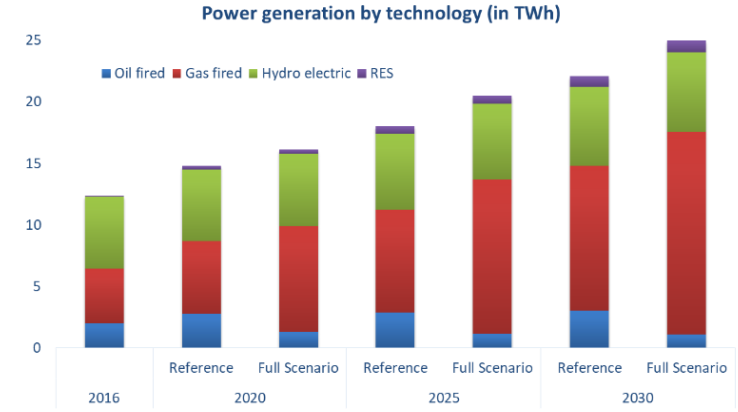
**Table N.1: Investment Matrix—Sectoral Contribution to Investment Demand of the Oil and Gas Sector**

| | Contribution to total investment demand |
|---|---|
| **Other equipment goods** | 80% |
| **Road: Passenger transport** | 10% |
| **Construction** | 5% |
| **Market services** | 5% |

### Stage 2: Modelling the Energy System of Ghana

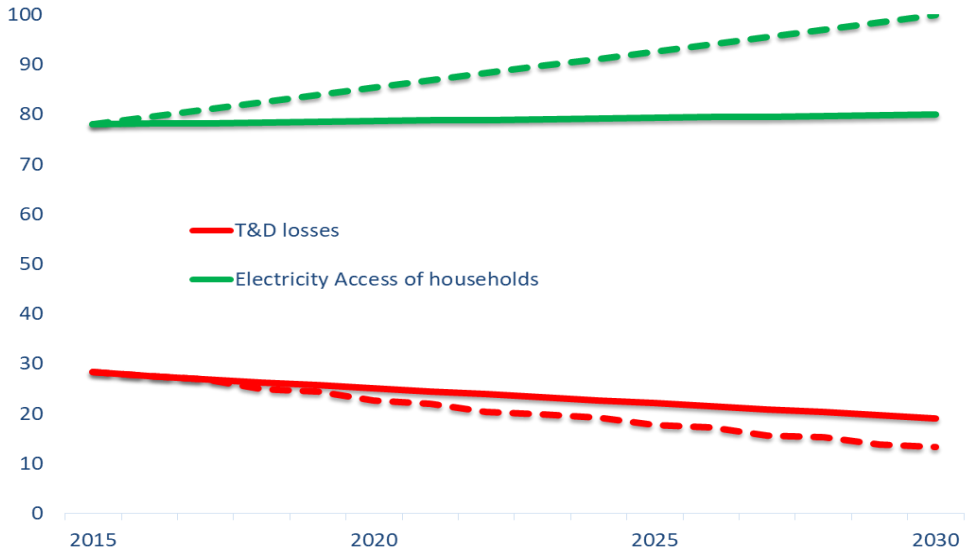
The model estimates the effects of changes in power generation (figure N.1), efficiency of the power grid (figure N.2), and the use of natural gas in the industry. The figures present the transformation of the energy system.

**Figure N.1: Projected Use of Power Generation Technologies (TWh)**




*Note:* TWh =Terawatt hours .

**Figure N.2: Electricity Access of households and Transmission and Distribution Losses in Ghana (%)**




*Note:* Solid lines represent the Reference Scenario, dotted lines represent the Full Scenario (period 2015–30). T&D = transmission and distribution.

## Stage 3: Modelling infrastructure

Infrastructure in the GEM-E3-G model is considered as an expenditure that increases the stock of infrastructure and is positively linked with productivity improvements. The decision to invest in infrastructure is set exogenously, and it is assumed to be taken by the government as either budget neutral (that is, with consumption reduction or tax increase to finance the investment) or financed by increasing or decreasing the public deficit or surplus. The motion equations (formulas [2], [3], [4]) for the different types of infrastructure are the following:

$$INFRS_{i,t} = INFRS_{i,t-1} \cdot (1 - depr_{i,t}) + INFRF_{i,t-1} \quad [2]$$

$$StockHC_t = StockHC_{t-1} \cdot (1 - deprHC_t) + FlowHC_{t-1} \quad [3]$$

$$StockEN_t = StockEN_{t-1} \cdot (1 - deprEN_t) + FlowEN_{t-1} \quad [4]$$

Where
$I$ = type of infrastructure (roads, telecommunication, railway)
$t$ = time
$INFR\boldsymbol{S}_{i,t}$ is the available **s**tock of infrastructure *i* at period *t*
$StockHC_t$ is the available **s**tock of human capital stock at period *t*
$StockEN_t$ is the available **s**tock of electricity grid network stock at period *t*
$INFR\boldsymbol{F}_{i,t}$ is the expenditure (**f**low) on infrastructure type *i* at period *t*
$FlowHC_t$ is the expenditure (**f**low) on human capital at period *t*
$FlowEN_t$ is the expenditure (**f**low) on power grid at period *t*
$depr_{i,t}$ is the depreciation of infrastructure type *i* at period *t*
$deprHC_t$ is the depreciation of human capital stock
$deprEN_t$ is the depreciation of power grid type *i* at period *t*

Infrastructure is linked to productivity through an exponential function that captures the infrastructure decreasing returns to scale (productivity increases for each doubling of capacity). Productivities (that is, total factor -***tfp***; labor – ***tgl***; energy - ***tge***) are composed of an exogenous part and an endogenous part (formulas [5], [],[7],[8],[9],[10]) which depends on the infrastructure expenditures:

$$tfp_{j,t} = tfp_{j,t}^{exo} + \sum_i map_{i,j} \cdot tfp_{i,t}^{infr} \quad [5]$$

$$tfp_{i,t}^{infr} = tfp_{i,t-1}^{infr} \cdot \left(\frac{INFRS_{i,t}}{INFRS_{t-1}}\right)^{elas_{i,t}} \quad [6]$$

$$tgl_{j,t} = tgl_{j,t}^{exo} + tgl_t^{infr} \quad [7]$$

$$tgl_t^{infr} = tgl_{t-1}^{infr} \cdot \left(\frac{StockHC_{,t}}{StockHC_{t-1}}\right)^{elasHC_t} \quad [8]$$

$$tge_{j,t} = tge_{j,t}^{exo} + tge_t^{infr} \quad [9]$$

$$tge_t^{infr} = tge_{t-1}^{infr} \cdot \left(\frac{StockEN_{,t}}{StockEN_{t-1}}\right)^{elasEN_t} \quad [10]$$

Where
$map_{i,j}$ is the mapping/association between upgrade of infrastructure of type *i* and economic activity *j*
$tfp_{j,t}$ is the total factor productivity of activity *j* in time *t*
$tgl_{j,t}$ is labor productivity of activity *j* in time *t*
$tge_{j,t}$ is energy productivity of activity *j* in time *t*

$elas_{i,t}$, $elasHC_t$, $elasEN_t$ are the elasticities that show by how much the productivity will increase for each doubling of the capital stock. These are derived from the respective literature (table N.2). A detailed analysis on the needs on infrastructure for Ghana can be found in "Ghana's Infrastructure: A Continental Perspective" (World Bank 2010).

**Table N.2: Ghana Physical and Human Infrastructure Elasticities, 2015**

| Type of investment | Initial stock | Construction cost ($ per km) | Elasticity (1,2,3,4,5) | *Share in public O&G revenues* | *Share in O&G revenues with education* |
|---|---|---|---|---|---|
| Rail lines (total route km) | 947 | 1,450,000 | 2% | *13.0%* | *3.1%* |
| Road network (total route km) | 67,450 | 850,000 | 3% | *36.2%* | *8.7%* |
| Communication (000 Internet access) | 9,653 | 1,000 | 6% | *17.2%* | *4.1%* |
| Power grid (transmission grid in km) | 5,900 | 187,500 | 3% | *33.6%* | *8.1%* |
| Education (in US$ million) | 20211 | | 21% | *n.a.* | 75.9% |

*Source:* For transport infrastructure, see Transport Indicators Database 2000–2009, Republic of Ghana, Ministry of Roads and Highways; for Internet access, see Internet World Stats, database, http://www.internetworldstats.com/stats1.htm; for power grid, see Electricity Company of Ghana, "About the Power Sector in Ghana," http://www.ecgonline.info/index.php/about-the-power-sector-in-ghana.html; for education, see World Bank data, "Expenditure on Education as % of Total Government Expenditure (%)," https://data.worldbank.org/indicator/SE.XPD.TOTL.GB.ZS?locations=GH&name_desc=false.

[1,2] Rows one and two, Moreno and Lopez-Bazo 2007; Jiwattanakulpaisarn, Noland, and Graham 2011; Yu et al. 2013; Na, Han, and Yoon 2013; and Deng 2013.

[3,4] Rows three and four, adjusted from Estache and Garsous 2012.

[5] Row five, Odior 2011.

The decision to upgrade infrastructure $(INFRF, FlowHC, FlowEN)$ is set exogenously. Demand for infrastructure is serviced by different economic branches depending on the type of infrastructure required. Human capital is provided through the services branch (education), whereas rail and roads are provided by the construction branch.

**Variant 3: Ghanaian Debt**

The most recent International Monetary Fund forecast (IMF 2017) foresees that "all debt indicators [of Ghana] are expected to improve and stabilize, the public debt would decline below the benchmark of 56 percent only by 2022." In the current study it is assumed that the government of Ghana can render its debt sustainable until the end of the study period in the Reference Scenario, without the aid of oil and gas revenues. Debt sustainability means that the government income is sufficient to service its debt; hence, the government borrows at comparatively low interest rates.

In the Reference Scenario, government revenues do not include oil and gas revenues, and the government is assumed to keep on implementing its current fiscal consolidation program (rationalizing expenditures and increasing revenues).

The model splits the debt into short-term (42 percent of total debt) and long-term (58 percent of total debt). Short-term debt is refinanced every year, and long-term debt every 10 years. In 2017, the proportion of the service of the government debt to the government revenues was 40 percent. The Reference Scenario projects this proportion to be reduced to 20 percent in 2030.

The model assumes that a debt reduction to below 50 percent of gross domestic product (GDP) has no impact on the borrower interest-rate level; hence, further debt reduction (below the threshold of 50 percent of GDP) has a small effect in the domestic economy.

**The Social Accounting Matrix (SAM)**

The input-output (IO) table of 2015 was provided by the Statistical Office of Ghana. It was used to update the Global Analysis Trade Project database. Because in 2015 the oil and gas industries have not yet grown to their full potential, the GEM-E3-G model was subjected to a dynamic calibration (Capros et al. 2013, 113). This calibration projects the IO structure by considering known economic structural changes and by disaggregating the relatively small 2015 oil and gas sector. More specifically, the oil and gas production structure was made similar to typical industry with the best technology available. Sales of the crude oil were directed to exports (with some crude oil processed in the local refinery), and the sales of gas are directed to power generation.

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