



Review Article – Energy

An overview of the natural gas sector in Tanzania - Achievements and challenges

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Abstract

In the recent years, Tanzania has discovered a lot of natural gas reserves which are expected to influence positively the socio-economic and political development of the nation. It provides the potential opportunities to government, domestic and foreign companies and the local community. However, the main objective of any natural resource management is to assist the country to realize the actual economic growth of its people. This paper, therefore, is intended to provide the overview of the natural gas sector in Tanzania. It analyses natural gas history, reserves, extraction and supply; infrastructure; market and pricing; and it moreover, evaluates the achievements and challenges facing the natural gas industry development.

Keywords: Natural gas infrastructure, natural gas, pricing, natural gas reserves, processing

Introduction

Safeguarding access to cheap, consistent, viable and modern energy for all people is one of the sustainable development goals (The European Union, 2016). Natural gas is a resource that is an alternative energy source in many countries in the world. Natural gas usually has a lot of socio-economic and political benefits in the country (Dong *et al.*, 2017; Mac Kinnon *et al.*, 2018) and is also used as raw materials in some industries. It has gained the priority due to the environmental significance regarding its cleanness and efficiency compared to other energy sources such as fuel which produce a lot of carbon emissions to the environment (Mac Kinnon *et al.*, 2018; Yijun and Li, 2016; Zhang and Liu, 2018; Zhen and Qing, 2017). It is considered as a clean, highly efficient and low-carbon energy source (Zhang *et al.*, 2018).

In Tanzania, currently, the energy potentials include natural gas, hydropower, coal, uranium oxide, biomass, solar and geothermal power (The European Union in Tanzania, 2016). However, the main source of the electricity is natural gas. The natural gas exploration along with the study continues and the main expectations are to continue to discover more natural gas. Natural gas is rapidly growing due to the government's desire to have industrial economies and thus require gas for electrical and energy-efficient industries and therefore give rise to good expectations in the future (Liang *et al.*, 2012). Depending on the state of investment and implementation of relevant policies, regulations and regulations, the natural gas sector has the ability to bring great benefits to Tanzania. Currently, the natural gas extracted is for domestic use rather than exportation (Amanam, 2017). The government has begun its efforts to build infrastructures for distributing the gas for domestic use. For that reason, the exportation to gain foreign currency will be done after the project of completion of the converting natural gas into liquid

"LNG" project (OpenOil, 2015b).

Since the discovery of natural gas in the recent years, there has been a deception informed to the Tanzanians, that the natural gas benefits will be given in cash to the people (Ndimbwa, 2014). In this regard, the fact is that the people will not be given money through mobile networks or their bank accounts. But citizens will benefit from this resource, in a different manner, some will get direct and indirect employment opportunities (Anderson *et al.*, 2017). Some Tanzanians will provide services in the areas where natural gas projects are taking place. Others are employed as the technical experts in the projects relating to the natural gas (Sutton, 2014). Secondly, natural gas is very important for electric power supply, which is used in manufacturing industries, homes and cars (Aggeliki, 2014). Finally, through natural gas, the country will gain foreign currency by purchasing LNG in the foreign countries after the "LNG" project (Liquefied Natural Gas) is completed. In addition, the use of natural gas reduces the national spending of foreign currency in ordering the fuel to operate the industries (Cohen and Korner, 2016). So, all these factors will be a catalyst for the fast-growing national economy. The natural gas policy contends that the natural gas resource found in Tanzania belongs to the people and must be accomplished in a way that benefits the intact Tanzanian society (URT, 2013).

This paper is intended to review the current status of natural gas industry development in Tanzania; including history, reserves, gas extraction and supply, infrastructure, market and pricing; and it furthermore overviews the achievements and challenges of natural gas sector development.

The status of the natural gas industry in Tanzania

History of the natural gas industry in Tanzania

According to the Tanzania Ministry of Energy, Tanzania's natural gas study has been in existence since 1952, and the first discovery of natural gas was made in 1974 in Songo Songo area, Kilwa district in Lindi region (Demierre *et al.*, 2015; Kinyondo and Villanger, 2017). Eight years later in 1982, the second discovery took place in Mnazi Bay area in Mtwara region. The discovery of the natural gas reserves in these areas promoted gas research on the coastal and off the coast areas (Reuters Staff, 2016). Studies were carried out by international oil companies. There has been another great discovery in the areas of Mkuranga, North Kiliwani and Ntorya (OpenOil, 2015a). According to the Tanzania Petroleum Development Corporation (TPDC), the history of oil and natural gas in the country has been divided into five phases: First phase: 1952-1954, Second phase: 1969-1979, Third phase: 1980-1991, Fourth phase: 1992-1999, and the Fifth phase is 2000 to date.

Phase One: 1952-1964

This phase consisted of British Petroleum (BP) Group and Shell companies who were given part of research and extraction in the coastal region. These include the Mafia Islands, Pemba and Zanzibar (Unguja). Wells' drilling did not detect enough hydrocarbons for commercial purposes. However, the natural gas was not developed since it seemed to have no economic impact at that time (Roe, 2016).

Phase Two: 1969-1979

This phase had two major events in the history of oil and gas in the country. The first was the establishment of a state-owned enterprise, the TPDC in 1969 (Melyoki, 2017), and second, largest discovery of natural gas in Songo Songo area in Lindi region. After the establishment of the TPDC, the first contract for the production (PSA) was signed between TPDC and AGIP (Aziende Generale Italian Petroleum - Italian Oil Company) in the area under the supervision of BP and Shell in the First Phase. In 1973, AGIP entered a joint venture with the company of AMOCO by excavating five wells, three in inland and two in offshore. Other studies indicate that the total of six islands was dug by AGIP and AMOCO while three inland and three quarters away from the coast. The discovery led to a significant discovery in Songo Songo area in 1974. The discovery was confirmed by TPDC in its three well-known programming programs from 1975 to 1979. Starting in 1978, TPDC went into research on coastal areas. The studies were conducted in the shores and coastal areas of the Ruvu, Kimbiji/Bigwa, and Pemba, Mafia, Zanzibar and Ruvuma (Paasch, 2015; Publish What You Pay-Tanzania Coalition, 2011).

Phase Three: 1980-1991

It was during this period that the Government approved the Petroleum (Research and Production) Act in 1980, with a gas discovery in the Mnazi Bay area (TPDC, 2014). Between the five phases, extraction occurred in this third phase and

this was caused by the petition of petroleum law and the rise petrol prices in the early 1980's. The government company, TPDC, entered the Songo Songo development by drilling two wells of the Great Kimbiji and East Kimbiji (EIA, 2013). The Shell Company, the IEDC (The Institute for Economic Development), and the Camarco Group, Elf, and AMOCO were licensed for oil and gas research (Paasch, 2015; The Business Journals, 2017). The Shell Company and later Esso were granted five licenses covering Ruvu and Selous Valley in 1981.

Phase Four: 1992-1999

This phase had a few research activities in its early years, the need for new researchers, and the government's decision to further develop the mining entities of the Songo Songo area were complimentary (TPDC, 2014). The TPDC and the Tanzania Electric Supply Company Limited (TANESCO), collaborating with Canada, Ocelot and Trans-Canada companies, were enthusiastically involved in the promotion, supply and energy use of the Songo Songo area (The Business Journals, 2017). The release of research licenses in 1995 on coastal basins for international companies, including the Tanganyika Oil Company, Exxon Mobil, Shell, KUFPEK (Kuwait Petroleum Research Company) and AMOCO increased the rapidity of research accomplishments. Tanganyika Oil Company drilled two wells in the Mandawa Basin in 1996/97 (OpenOil, 2015a). Furthermore, the research agreement was contracted between TPDC and the Canadian company of Atrim Energy Limited and the Canop World-Wide and the Ndovu Resources of Australia (Isaksen *et al.*, 2017).

Phase Five: 2000 up to now

The five companies were licensed to work during this period, including the company of Petrobras (Block 5) in 2004, Ophir Energy (Block 1) in 2005, Ophir Energy (Blocks 3, 4) in 2006, and Statoil (Block 8) in 2012 (TPDC, 2014). The release of these licenses was followed by research and extraction of wells with the company BG Group (Blocks - 1, 2, 3), Statoil (Block - 2) and Petrobras (Block - 5), which led to a significant gas discovery in the Blocks 1, 2, 3 and 4. In March 2012, Statoil and ExxonMobil's company made the largest discovery of natural gas reserves off the coast in Zafarani. Songo Songo and Mnazi Bay entered into a successful business activity in 2004 and 2006 respectively. Until June 2012, there were 26 Treaty Contribution Agreements (PSA) signed by 18 oil research companies. In the efforts of managing the natural gas industry, the government approved the Tanzania natural gas policy in 2013, which affects challenges associated with natural gas management and the management of good management of this industry (Lovett *et al.*, 2014). The summary of the history of the natural gas sector in Tanzania is shown in Table 1.

Table 1: The summary of the history of the natural gas sector in Tanzania

Phase	Period (Year)	Activities
1 st	1952-1964	First research and extraction of natural gas in coastal areas
2 nd	1969-1979	Continuation of the research on natural gas on shores and coastal areas Establishment of TPDC in 1969 The first discovery of the natural gas in Songo Songo area in Lindi region in 1974
3 rd	1980-1991	The enacting of the Petroleum (Research and Production) Act in 1980 The discovery of natural gas in Mnazi Bay area in Mtwara region in 1984

Table 1 Continued.....

4 th	1992-1999	The increase in natural gas research and extraction activities The collaboration among the TPDC, TANESCO, Tanganyika Oil Company and other international companies such as Ocelot, Trans-Canada, AMOCO, KUFPEK, Shell, Exxon, Mobil to conduct natural gas activities
5 th	2000-Up to date	The increase of international companies for the natural gas activities Songo Songo and Mnazi Bay gas projects entered the successful business activity in 2004 and 2006 respectively The adoption of the National Natural Gas Policy in 2013 The adoption of the Local Content policy in 2014 The enacting of the Oil and Gas Revenue Management Act in 2015 The enacting of the Petroleum Act in 2015

Reserved and discovered natural gas quantity

The deep seas discoveries have brought about new exploration goals for hydrocarbons in Tanzania and whole of Western Indian Ocean area (URT, 2013). The Ministry of Energy confirmed that the total discovered reserves amounted to 57.25 TCF in 2016 (Energy and Water Utilities Regulatory Authority, 2017) from the 40 TCF in 2012 (Roe, 2016) and 53.228 TCF in 2014 (TPDC, 2015a), as shown in Figure 1.

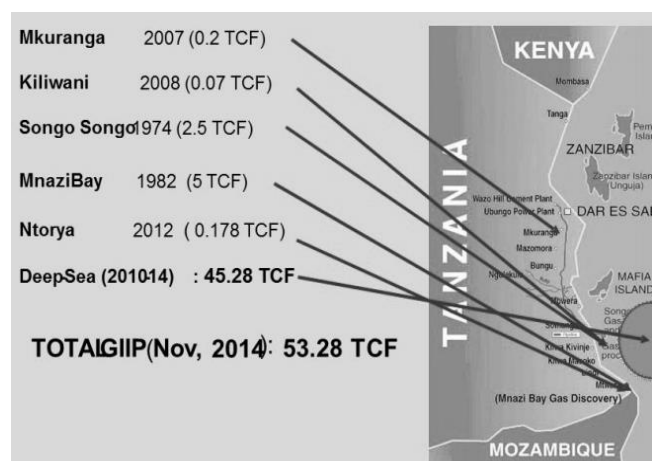


Figure 1: The quantity of discovered natural gas by 2014

Gas processing, extraction and consumption

Natural gas processing is an industrial practice that cleans raw natural gas by sorting out impurities and numerous non-methane hydrocarbons and fluids to yield what is recognized as pipeline quality dry natural gas (Dalane *et al.*, 2017; He *et al.*, 2018). In Tanzania, nearly all of the natural gas produced is used for generation of electricity (George, 2014; Tanzania Invest, 2018). Presently, and perhaps for some years to come, this will be the major use of natural gas in Tanzania. Liquefied natural gas (LNG) processing becomes the main product somewhat further down the line (Isaksen *et al.*, 2017). The natural gas production is estimated to be 138,389 million standard cubic feet (MMsft³) between the years 2011 to 2015, with the value of US \$519.8 million, as shown in Table 2.

Table 1: Gas production in Tanzania from 2011-2015

Year	Gas produced (MMsft ³)	Value (US\$ million)
2011	31,636	84.1
2012	36,934	107.3
2013	35,937	119
2014	33,845	103.5
2015	37,176	105.9
Total	138,389	519.8

Since 2012 the annual increase has been modest, around 0.7% annually. Most of Tanzania’s natural gas is produced

at Songo Songo gas plant, as Mnazi Bay gas plant started production in 2015.

Natural gas is believed to contribute mostly to the electric power generation in Tanzania. In 2017, natural gas contributed about 625.5 megawatts (MW) of the total power installed capacity (1,450 MW) followed by 609 MW of hydropower and 188.5 MW of liquid fuel (Ministry of Energy and Minerals, 2017). The electric power generation based on gas in Tanzania takes place mainly in Dar es Salaam where most of the processing plants are located. Songo Songo Thermal Power Station is the largest gas-fired power station in East Africa with an installed capacity of 189 MW.

Additionally, Independent Power Producer (IPP), Symbion, operates a power plant, Ubungo II Thermal (120 MW) in Dar-es-Salaam (Ng’wanakilala, 2017; TANESCO, 2017b). Government under TANESCO controls five gas-driven plants: Ubungo I (100 MW) and Tegeta (45 MW) situated in Dar es Salaam and 3 stations located outside Dar es Salaam region (TANESCO, 2017a): Mtwara Thermal Power Station (18 MW) (TANESCO, 2018b), Somanga Thermal Power stations (7.5 MW) and Kinyerezi I Thermal Power Station (150 MW) (TANESCO, 2018a).

LNG processing

The investment in an LNG plant in Tanzania has lately been estimated at US\$30 billion (Tanzania Daily News, 2016). The contributors to the project, besides Statoil of Norway and the Tanzanian state-owned TPDC, are Shell, ExxonMobil and Ophir Energy (Ng’wanakilala, 2016). Their joint venture could become the first in the country. An exact timeline to form the LNG facility is not yet clear; analysts have estimated a period of seven years. The plant situated in the area of Likon’go, Mchinga district in Lindi region and has a lifespan of 40 years succeeding the start-up (Isaksen *et al.*, 2017). Tanzania looks impatient to comprehend the project. Development in Mozambique will contest with Tanzania’s LNG exports. However, President Magufuli was quoted to say that the development of the project is taking too long (Daily News, 2016; Ng’wanakilala, 2016). He has advised the Ministry of Energy to cooperate with the project members through the TPDC and partners from other relevant ministries to quicken the start of construction (Ng’wanakilala, 2016).

Natural gas infrastructures

For almost 20 years since the discovery of natural gas in the country, the Government in collaboration with various stakeholders continued to conduct research on how to use the resources. The final study was completed in 1991 when the construction of natural gas purification plants on the island of Songo Songo area along with the pipeline for exporting natural

gas to Dar es Salaam was built (The World Bank, 2005).

The government borrowed funds from the World Bank and the European Investment Bank (EIB) to implement the project. The implementation of the natural gas project at Songo Songo area had the following goals (ORCA, 2010; The World Bank, 2012):

- Reducing hydro-dependent hydro-resistant electricity that is affected by climate change such as drought;
- Reducing foreign currency used to import oil for generating electricity;

- Sharing private sector into the energy sector; and
- Attracting the interesting investors in oil and natural gas exploration activities in the country.

In order to increase effectiveness in the implementation of the project, it was advised that the government undertake the project through a partnership with the private sector and that a Special Purpose Vehicle was created to implement and manage the project, hence the Songas Company was established (Yescombe, 2017). Figure 2 shows the structure of the implementation of the natural gas project at Songo Songo area.

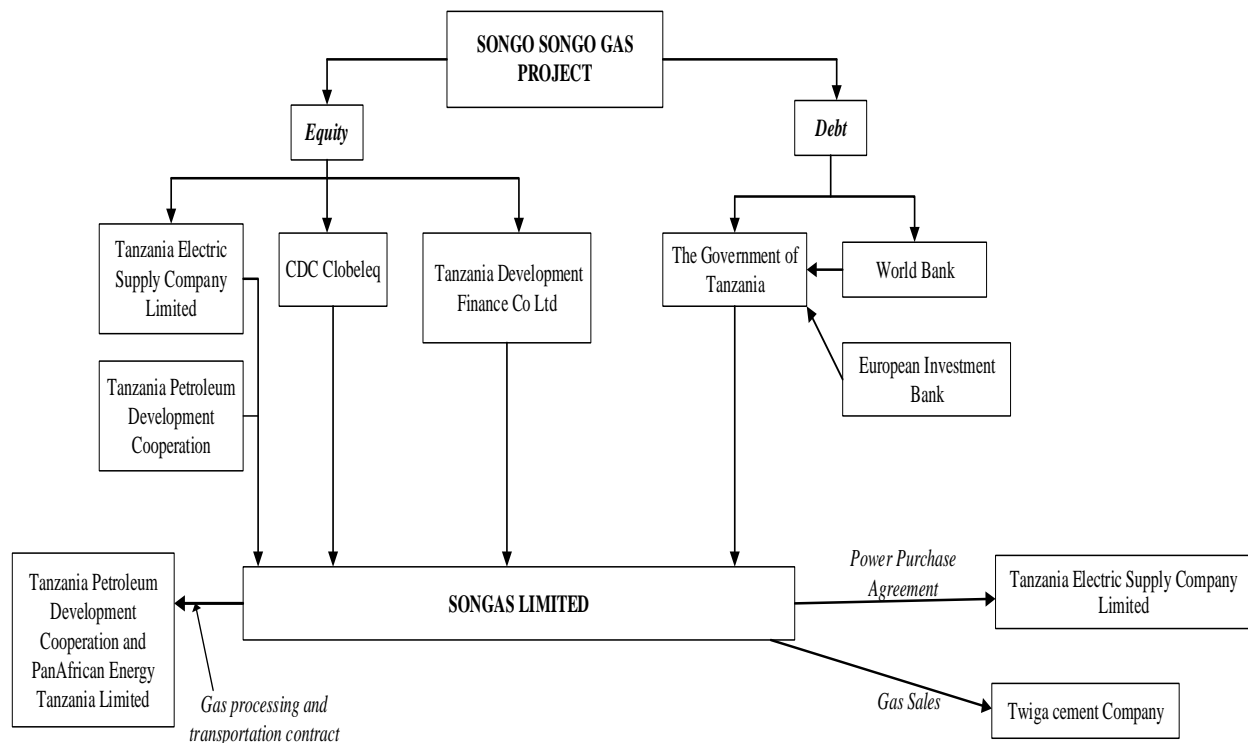


Figure 1: Songo Songo gas project structure

In order to achieve the implementation of the project, Songas was awarded the wells number 3,4,5,7 and 9 which were mined by the government through TPDC in the Songo Songo area to manage them. In addition, in 2001, the government entered into the PSA with the Pan African Energy Tanzania Limited (PAET) Company for the development of Songo Songo area(Corporate Digest, 2018). Through the PSA of 2001, Songas awarded PAET the responsibility of managing wells by entering the operatorship agreement.

The project took approximately 3 years and completed in July 2004 involving the construction of natural gas purification plants at 70mmscf/d and a 247 km natural gas pipe Songo Songo (Lindi region) to Dar es Salaam (TOGACE, 2016). The cost of the project was approximately US \$225,347,062. The completion of the project will generate significant relief in electrical production activities as approximately 300 megawatts are produced using natural gas daily. In addition, the original gas is used in 37 factories, 60 vehicles, 70 homes, 1 hotels and 2 institutions (Keko Prison and Mgulani JKT) (The European Union, 2015).

In 2006, the Artumas Company also succeeded in developing the Mnazi Bay blocks by resurrecting the rights(Maurel et Prom and Wentworth Resources Limited, 2015; Reinsch, 2006). It was discovered in 1982 by the Agip Company and added other three wells. The development of the block was associated with the construction of a small gas purification plant capable of cleaning 10 million cubic feet a day and the construction of an average 7-kilometre natural gas pipeline from Mnazi Bay to Mtwara urban. An estimated 2.1 million cubic feet are used to generate electricity on TANESCO plants in Mtwara Region and that serve the Mtwara and Lindi regions (TANESCO, 2018b). The project costs US \$47,590,824 (Tanzania Invest, 2016).

Expansion of infrastructure

Since the launch of the Songo Songo infrastructure, the demand for natural gas in the country increased dramatically and caused the burden to the infrastructure to cope with the increase. To deal with the challenge during the transition, Songas was required to adjust the Thomson Valve to increase the power of the natural gas purification plant from 70 million cubic feet to 110 million cubic feet (TPDC, 2015b).

According to the contracts entered in 2001, Songas was given the first opportunity to invest in natural gas supply infrastructure whenever the opportunity arose (Boma, 2013). In order to increase the availability of natural gas in various efforts were made including:

- Expansion of infrastructure: The project was created by Songas but failed to be implemented by 2008;
- Extension of infrastructure: The project was created by Songas and PAET to increase 35 million cubic feet per day. The project also failed to be implemented;
- The Rak Gas Project: The Company intended to build natural gas purification plants and tap from Mtwara to Mombasa. This project was also unsuccessful.

Following the Songas and PAET Company proposing a proposal to expand natural gas infrastructure, EWURA rejected the proposal with the statement that expansion costs were higher than the growing volume of natural gas. Songas and PAET companies recommended spending approximately 121 million US dollars to increase 35 million cubic feet per day (Isaksen *et al.*, 2017).

To deal with the challenges of natural gas infrastructure shortages in the country and the failure of Songas to fulfil its obligations, the government decided to establish a process for funding to increase the infrastructure.

Information of the new natural gas infrastructures built by the government

The natural gas infrastructure project involves mechanical construction to clean natural gas in Madimba area (Mtwara region) as well as Songo Songo (Lindi region) and pipeline for exporting natural gas from Mtwara, Lindi and the Coast up to Dar es Salaam (Editor, 2016; Mirondo, 2017). In the area of Madimba, the Three (3) Fieldsable to clean up 70 million cubic feet each day is built. Two other (2) machines have the ability to clean up 70 million cubic feet per day is built in Songo area Songo. The natural gas operating machines in Madimba area (Mtwara region) will clean the natural gas from the area Mnazi Bay, Northwest and Great Lakes (Mirondo, 2017). Songo Songo machines (Lindi region) will clean the natural gas from Songo Songo area, Kilwani and deep sea.

The pipeline for transporting natural gas originates from the Madimba area (Mtwara region) and connects to the pipeline which comes from Songo Songo area in the Somanga pass (Lindi region) through the coast to Dar es Salaam (Offshore Technology, 2017). Construction of the Pipeline has the following components:

- A diameter of 36-inch diameter and 290 km, from Madimba to Somanga Funga;
- A diameter of 36-inch diameter and 197 km long, from Somanga pass to Kinyerezi area in Dar es Salaam region;
- Pipe diameter 24 inches and 25 km height; from the island Songo Songo through the oceans and connecting to the pipeline from Mtwara region in the Somanga Region area; with
- A diameter of 16-inch diameter and 30 km from Kinyerezi area to Tegeta area in Dar es Salaam.

Built-in tap has the ability to transport natural gas 784 million cubic feet a day and reach 100 million cubic feet for a day if the compressor will be added. In addition, the pipeline has been set aside for removing valves in Mtwara, Lindi, Kilwa, Somanga Funga and Mkuranga areas to ensure that the areas have access to natural gas (Tanzania Invest, 2016).

These inlets will be used to export natural gas to industrial, home-based, electrical power plants and other emerging applications. With these versions, the pipeline has been provided for ties in valves from natural gas stations, such as the Muranga, Ntorya and the Great Sea (Bungane, 2017; Mwamunyange, 2017).

Project costs

The cost of the project is the US \$1,225,327,000, of these funds the Exim Bank of China has contributed 95% to the Government of Tanzania 5% (OutLaw, 2015; TPDC, 2015b). The amount of money is used to cover the following areas:

- Songo Songo natural gas purification plant costs US \$151,735,000;
- Natural gas purification plant of Mnazi Bay costs the US \$197,877,000;
- Pipeline for exporting natural gas costs the US \$ 875,715,000.

The benefits of the construction of natural gas infrastructure

Implementation of this project will bring great benefits to our nation and its citizens including:

Low-cost and cheaper electricity: Implementation of this project will enable our country to obtain reliable and affordable electricity (Levy, 2018). When it comes to the infrastructure, it will save more than \$1 billion (the US \$1 billion) equivalent to \$1.6 trillion per year that is currently used to import fuel for the use of existing machinery in the country (OpenOil, 2015c). Likewise, new built-in plants will get natural gas producing affordable electricity (WorleyParsons, 2015). "With this infrastructure in place, more investors be attracted in the upstream sub-sector as well as other sectors of the economy by assuring them the availability of reliable power (Frankson, 2015).

Growth and industrial increase: The completion of this project will stimulate industrial development in the country since many industries have shown the intention of using natural gas energy in its production. In addition, reliable electricity will reduce production costs and make Tanzania's products competitive in the international market (The European Union in Tanzania, 2016).

Environmental conservation: The completion of this project will stimulate natural gas consumption in domestic and transit operations and thus reduce environmental pollution caused by the use of charcoal and wood in our country (Felix and Gheewala, 2011).

Employment opportunities creation: The completion of this project will stimulate the availability of many new jobs in the country due to the existence of reliable electricity in the industrial, rural and commercial sectors (OXFAM, 2015).

Natural gas use in natural gas pipelines passing areas: The

natural gas pipeline has set up off-take inlets in Mtwara, Lindi, Kilwa and Mkuranga areas, to ensure that these areas receive natural gas for exporting existing and built-in industries, homes, electrical power plants and any natural gas demand that will arise.

Clean water: In natural gas purification plants in Madimba and Songo Songo areas, the water purification plants will be built and will help to provide clean water in surrounding villages. So far the contractor has completed three mining waterfalls in Madimba area with a capacity of 150 cubic meters per hour (150m³/hr.). Part of the water will be used in the natural gas purification plant and the other part will serve the villagers.

Provision of industrial energy: Natural gas is used as raw materials in various industries; Fertilizers, Chemicals (Petrochemicals), Aluminum and Manufacturers of Plastic Materials. The establishment of new industries due to natural gas consumption will stimulate the industrial growth of the country and with the acquisition of many new employment opportunities to the youth (BMI Research, 2016).

The natural gas pipeline construction project is very important for the implementation of the 2025 Development Vision. Tanzania has entered into the natural gas economy, and infrastructure of this type of economy must be invested. Furthermore, the construction costs for our pipeline are very cheap to compare the construction of the same portfolio to the world.

Natural gas market and pricing

Since natural gas has fairly high transportation charges between continents, its price has been mostly set in a continental market (Brown, 2017). Globally, the natural gas price is under the influence of the market and the price of fuel (Li *et al.*, 2017). It varies over time and across the international markets (Zhang *et al.*, 2018). The natural gas price is properly assessed by gas production, transmission, distribution and consumption costs (Giziene and Zalgiryte, 2015). In general, the natural gas prices are the function of market supply and demand, as shown in Table 3.

The natural gas extracted in Tanzania is for the domestic use. The main natural gas consumers are industries, household, hotels, power generation and compressed natural gas producers. Currently, the natural gas prices are conveyed between the buyer and the government-owned Tanzania (TPDC), which is the seller. EWURA is responsible under Section 29(2) of the Petroleum Act, 2015 to control and apply tariffs, rates, charges and fees payable

Table 2: Major influential factors towards natural gas prices

Major influential factors	
Demand	Supply
Level of economic growth	Level of natural gas storage
Competition from other energy sources particularly fuels	Volumes of natural gas imports and exports
Variations in the seasons particularly winter and summer weather	The total amount of domestic natural gas production

Government revenue

The government collects the money which is used in different public services such as infrastructure construction, water supply, healthcare, and education. The finance is from the natural gas activities regarding service levies, taxes, pay as you earn. For instance, from the year 2010 to 2015, the

by a licensee in respect of controlled activities. Section 164 of the law offers stakeholders inputs as a pre-requirement: where the stakeholders should be involved in determining tariffs, rates or charges for natural gas. EWURA must issue the indicative natural gas prices and publish the approved prices at least once per year through local newspapers. The natural gas price in Tanzania is approximately US\$ 5.12 per 1,000 cubic feet (Mwamunyanje, 2016), or from US\$ 3.17 to US\$ 16.25 per million British thermal units (MMBtu) (EWURA, 2016).

Achievements and challenges for natural gas sector development

Achievements in the natural gas sector

Following the large of natural gas discovery in the deep-water, the government and the natural gas operating companies have decided to invest in a huge natural gas production in order to bring more productivity to the nation and its people. The country has achieved to gain the following benefits from the use of natural gas in different areas.

Electricity sector

Electricity sector started using natural gas since July 2004, so far 625.5MW is produced in the country using the using natural gas. Approximately more than the US \$4.4 billion, equivalent to Tshs 7 trillion, has been saved using the natural gas power supply from July 2004 to March 2016 (Ministry of Energy and Minerals, 2017).

Industrial sector

The 42 industries have already been linked to natural gas infrastructure (Ministry of Energy and Minerals, 2017). Statistics show that 42 factories using natural gas have reduced energy costs to more than the US \$400 million, equivalent to Tshs. 640 billion, compared to whether they would use oil in their operating systems for the period from July 2004 to December 2015.

Transport sector

To date, 40 cars have been set up for the use of natural gas. This system is used in conjunction with the existing fuel system (Peng and Poudineh, 2017). For the period from May 2011 to March 2013, the vehicles have spent a value of Tshs. 22.88 million. For the same period, the vehicles could use fuel worth Tshs. 46.2 million. Thus, the savings saved by 40 cars using natural gas instead of petroleum for the period amounted to Tshs. 23.32 million.

government was able to collect about US \$263.6 million as Value Added Tax (VAT) and sales of natural gas from Songo Songo and Mnazi Bay gas projects, as shown in Table 4.

Revenue for Kilwa District Council in Lindi region; and Mtwara Rural District Council in Mtwara region

The law requires companies producing and selling

Table 3: Revenue received from gas sales from Songo Songo and Mnazi Bay projects from 2010 to 2015

Year	2010	2011	2012	2013	2014	2015	Total
Amount (US\$ million)	26.7	39.8	36.6	52.2	60.5	47.8	263.6

natural gas for service levy, which is 0.3% of Natural Gas sales. It is paid every three months of production (quarterly). The beneficiary councils are Kilwa (Lindi) from the project of Songo Songo and Mtwara Rural (Mtwara) from the Mnazi Bay project. For instance, Tshs 2.06 billion was collected by Kilwa District Council as service levy from companies dealing in the natural gas activities between 2011/21 and 2015/16 fiscal years. Tshs 196.3 million as the services levy from the natural gas production companies in the first two-quarters of 2016/17 in Mtwara Rural District Council (Kolumbia, 2017a). However, it is estimated that Mtwara Rural Council receives an average of Tshs 16 million annually. This amount is minor due to the low production and sale although existing wells at Mnazi Bay have the ability to generate more gas.

In addition, all gas projects such as energy, industrial, electrical installations and petrochemicals are largely dependent on the completion of the construction of a project for cleaning and exporting natural gas from Mnazi Bay gas plant and Songo Songo gas plant up to Dar es Salaam.

Enhanced legal and regulatory framework

Tanzania has placed a comprehensive legal and regulatory framework which accomplishes the natural gas industry. The government has numerous practical and supplementary policies and rules which affect the performance and activities of natural gas development. These policies and rules include the national natural gas policy of 2013, the Petroleum Act of 2015, the Oil and Gas Revenue management Act of 2015. The Natural Resource Act of 2017 and Tanzania Extractive Industries (Transparency and Accountability) Act of 2015, to mention the few (Breakthrough Attorneys, 2015).

Increased institutional capacity

Proper functioning of the natural gas sector has to be backed up by an efficient institutional arrangement. Different institutional such as the Ministry of Energy, the Ministry of Finance, TPDC and EWURA is responsible for natural gas sector management (Melyoki, 2017). However, the existing institutional framework faces some challenges in terms of management, operational and functional performance (Pedersen and Bofin, 2015). Consequently, there is the need for more dedicated and focused institutional framework which is fully equipped with financial and human resources.

Improvement in the corruption eradication in the natural gas sector

Since of the election of Dr Magufuli as a president in 2015, there is an improvement in the eradication of the corruption and embezzlement in the public sectors including natural gas sector (Anyimadu, 2016; Jacob and Pedersen, 2018). For instance, Tanzania was ranked 116 out of 176 in 2016 (Transparency International, 2016), but in 2017 improved by ranking 103 out of 180 countries (Transparency International, 2017).

Challenges of the natural gas sector

There are high expectations that exploitation of natural gas resource will significantly upsurge the country's national income. However, the slight revenues that Tanzania has acknowledged from the natural resources such as massive mineral extraction during the last two decades demonstrate the potential problems with such high outlooks (CMI Staff, 2014). The failure of natural gas disturbs the electricity supply in the country. Only 15% of Tanzania's energy accesses the electricity, this level inconsistent and unrelated to the expected development rate. According to the 2016 World Bank Statistics, small amounts of electricity available are not enough for the general needs of the nation (The World Bank, 2016). The number is low compared to neighbouring countries of Kenya and Mozambique with 19% and 20% respectively.

Energy availability is the key to economic growth anywhere in the world since is usually used in manufacturing industries to produce consumer products (Mathews and Reinert, 2014). But for the developing nations like Tanzania, the issue of energy sustainability and availability has become a paradox as it is experiencing constant fluctuations as well as the impact that has affected the economic development.

In case of the natural gas sector there are some challenges which face its sustainable development in Tanzania as explained below:-

- ❖ There is an increased demand for the professionals which the local market cannot support right now. However, the government continue to train the local experts and government staff in short, medium and long-term courses, conferences and attachments in the natural gas sector (Kinyondo and Villanger, 2017).
- ❖ The ineffective and inefficient regulatory tools for regulating prices of the natural gas in the sector results in large variations of gas prices between small, medium, and large industrial gas consumers (Kolumbia, 2017b).
- ❖ There is an infringement (violation) of natural gas way leave operated by TPDC and PAET. However, the government through EWURA intensifies compliance to HSE requirements as well as conduct public awareness programme (Calignano and Vaaland, 2017).
- ❖ Insufficient public knowledge and awareness in the understanding of policies, laws and regulations on the natural gas sector (Boffu, 2017). However, through different mass media and other means such as conference, training, workshops and meetings, the government continues to strengthen the implementation of a public awareness program to address this challenge.

Conclusion and Recommendations

The natural gas sector is very important for socio-economic and political development in Tanzania if the major

stakeholders will take their parties and work together. This will help to avoid the resource curse which is disturbing a lot of natural resource-rich developing countries. Furthermore, to achieve sustainable growth of the natural gas, there is the need for

- Improving the extent and quality of research that can contribute to more well-versed policy-making and public discussion in Tanzania, particularly on concerns linked to natural resource management for comprehensive growth; and
- Disseminating this research and knowledge to key decision makers and the general public

Furthermore, professional assessments and accumulation issues of oil and gas resources, undoubtedly show that African countries cannot be more than 25% of GDP, so it is wrong to think that the country will go forward in dependence on oil and natural gas only, but there is need of attracting other sectors of the economy. Thus, in general, it will identify and turn the sectors into focus by investing capital priorities and thus stimulating the country's economy and its economy.

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