Demand for natural gas in ghana environmental sciences essay

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TITLE OF THE

RESEARCH PAPER: HOW PROMISING IS GTL AS A MONETISATION OPTION FOR GHANA TO UTILISE ITS STRANDED GAS FROM THE JUBILEE FIELD?

ABSTRACT:

The discovery of oil and Gas in commercial quantities has given the opportunity to Ghana to promote its economic development. In view of this, the government of Ghana is taking the necessary steps to ensure the resources are put to good use. In this regard, the development of the Gas sector is of a major priority to the nation to meet local demand and the global market. Currently, Ghana is building a Gas plant in the Western Region. The overall goal of the project is to ensure that natural gas, associated gas and NGLs produced in Ghana are effectively and efficiently processed into clean fuels and feedstock for domestic, and export market; promote the development of petrochemical industries; substantially reduce and/or eliminate flaring of gas. Thus this paper seeks to identify the prospects of the GTL technology as a monetisation option for Ghana. WORD COUNT: 3558PRESENTED TO: Dr. Xiaoyi MU

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LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CO2Carbon DioxideTcfTrillion Cubic Feet

OECD Organization for Economic Cooperation and Development

GTLGas to LiquidN-GASNigeria GasWAGPWest African Gas PipelineMMCFDMillion Cubic FeetWAPCoWest African Pipeline CompanyMMBtuMillion British Thermal UnitGGFRPGlobal Gas Flaring Reduction PartnershipFPSOFloating Production Storage Off-loadingMPaMega PascalBSCFDBillion Standard Cubic Feet Per DayGHGGreen House GasBB/DBarrels Per Day

1. INTRODUCTION

The discovery of oil and gas in commercial quantities in Ghana has regenerated the hope for economic growth and development. The mining of oil in small quantities dates back to the late nineteenth century, but commercial discovery was made in 2007.[1]Currently, Ghana is gradually gaining grounds on the oil and Gas market with approximately 8, 880 barrels of oil per day in 2010 with proven reserves of about 660 million barrels by 2011. The major field of discovery is the jubilee field located offshore in deep water Tano and west cape three points.[2]Ghana is endowed with an estimated 4. 85 trillion cubic feet (tcf) in natural gas reserves[3]with 1. 2 tcf stranded in the jubilee field.[4]Natural gas can either be produced from associated gas or from a dry gas in an oil field. It is an empirical fact that the demand for natural gas is increasing as a result of its environmental friendliness in terms of low CO2 emissions and now plays a greater role in the primary energy mix than it stood thirty years ago.[5]The so called " premium fuel' 'argument by OECD countries owing to the fact that gas had so many benefits and was too unique to be burnt for consumption.[6]As a

result, it was illegal in the United States and the European Union to use gas for power generation.[7]The early 1990s saw a paradigm shift from this ideology and the barriers removed.[8]Today, natural gas is used in the residential sector for cooking and heating, as a primary energy to produce electricity, steel in the industries and as a feed stock for fertilizer, plastics, paints as well as medicines. From literature, it is globally accepted that natural gas is clean with numerous benefits. It is against this backdrop the government of Ghana is putting in place measures to monetize its " stranded gas' 'from the Jubilee field. The challenge facing the nation now is how to transport the natural gas and process it into different products to meet the local and international market. Thus, this paper seeks to study how beneficial will GTL as a technology option to monetize natural gas.

2. DEMAND FOR NATURAL GAS IN GHANA

The demand for natural Gas in Ghana is on the increase. This may be due to the perception of it being a much cleaner fuel and economical. Most commercial vehicles owners in Ghana have converted their cars into using LPG which they consider much cheaper to petrol. This has resulted in frequent shortages of LPG on the market to meet both residential and industrial demand. Between 2000 and 2011 alone, the demand for LPG rocketed from 3. 0% to 7. 8%.[9]Indigenous demand is projected to rise up to 280-300 mmcfd by 2015.[10]Currently, Ghana imports gas from N-GAS in Nigeria through the West African Gas Pipeline (WAGP). In 2011 alone, Ghana imported natural gas worth $74million in five months.[11]The figure seems to be quite alarming and reiterates how important natural gas is to the Ghanaian economy. The country is expected to take delivery of 30 million

cubic feet of Gas from Nigeria the in the same year.[12]The WAPCo tariff for natural gas transportation in 2011 through the WAGP was $4. 065 per MMBtu ($4. 139 per mscf) for standard customers and $3. 963 per MMBtu ($4. 035 per mscf) for foundation customers.[13]The average price of natural gas from the WAGP in 2011 was $2. 45 per MMBtu ($2. 499 per mscf).[14]The anticipated natural gas supply necessary to power all dual-fuelled thermal plants in the country is estimated to range between 180-200 million (mmscfd).[15]The Volta River Authority is the direct purchaser of gas from N-Gas to aid in the powering of thermal plants for hydro-electric power generation from the Akosombo Dam. It is estimated that there is a gas deficit of 100Mscf for gas demand in Ghana.[16]Figure 1 shows the outlook of gas demand in Ghana by 2020.

FIGURE 1: NATURAL GAS FORECAST FOR GHANA (MMSCFD)

Source: Compiled by Author- Energy Commission, 2010. From figure 1, the gap between the maximum and minimum gas required is the gas deficit in the country.

2. 1 Natural Gas Utilisation Project in Ghana

Ghana is still in the early stages in developing its oil and gas sector and for that matter the natural gas industry. The country is making some strides in ensuring that the resource find does not turn to be a curse but a blessing to the nation. In this regard, the government is putting in place the necessary institutional and regulatory frameworks to ensure that resources are put to good use. A major step in this direction was the setting up of the Ghana National Gas Company to ensure the processing and transportation of

natural gas from the Jubilee field for power generation and industrial use. Currently the countries quest to reduce gas flaring from the Jubilee field is backed by its zero gas flaring policy and a signatory to the Global Gas Flaring Reduction Partnership (GGFRP). According to the gas flaring policy, continuous gas flaring from the jubilee field would result in 1. 5 CO2 emissions per annum.[17]The nation at the moment uses 20 units of the gas produced to power the FPSO and the other 30 units used for re-injection to promote oil recovery from the Jubilee field.[18]Ghana's effort to promote zero gas flaring and gas utilisation prompted the development of the gas infrastructure project currently on-going in Atuabo in the Western. The main contractors of the 150 MMSCFD Gas Processing Plant is Sinopec International Petroleum Service Corporation. The project is estimated to cost $850 million. [19]The objective of the project is to process gas into slates of products for the petro-chemical industry, domestic and export market; and also aid in the generation of power.

FIGURE 2: POTENTIAL GHANA GAS INFRASTRUCTURE PROJECT

Source: Simpson, " Jubilee Gas Commercialisation'' 2008.

3. LITERATURE ON GTL

This chapter provides an overview of the GTL technology, the processes involved, the economics and benefits of the technology.

3. 1 What Is GTL?

Gas to liquid is a process involving the chemical transformation of natural gas into synthetic crude that has the probability to be processed into high

quality hydrocarbon fractions.[20]GTL technology utilises natural gas through a Fischer-Tropsh synthesis process to produce ultra clean hydrocarbons including kerosene, diesel fuel, wax and Naptha.[21]

3. 2 Overview of GTL Technology

GTL technology emerged in Germany in the 1920's developed by Fischer and Tropsh. The technology was developed on the Fischer-Tropsch (F-T) synthesis process which involved the turning of coal into gas and later into liquids.[22]Fischer and Tropsh in 1923 testified the development of hydrocarbons based on alkalized irons. Fisher and Tropsh in their further studies into GTL-technology came up with the proposition that the use of a catalyst under favourable temperature, pressure conditions, a combination of hydrogen and carbon dioxide referred to as syngas could be transformed into waxy paraffin's.[23]It is interesting to note that Fischer-Tropsh technology is not constrained to the use of conventional gas as a primary product for monetisation but can make use of coal seam gas, non-associated natural gas, associated gas; biomass or coal.[24]These primary sources can be transformed into high quality distillates under the F-T technology by altering the temperature, pressure and catalyst conditions.[25]Gas- based- F-T technologies are based on two classifications; namely the High temperature Fischer Tropsh, involving the processing of gasoline and diesel fuel under temperatures of 320ºC with about 2. 5 MPa of pressure and Low-Temperature Fischer Tropsch producing diesel fuel free of aromatics and sulphur under temperatures ranging between 22-240ºC with 2. 0-2. 5 MPa of pressure.[26]

3. 2. 1 GTL Cycle

GTL technology under the Fischer-Tropsch process involves three fundamental steps which demand a unique infrastructure and a secure supply of gas feed to perform efficiently. The GTL process splits molecules from natural gas apart and congregates them into a long chain of molecules resulting in the production of products free of aromatics, metals and sulphur. [27]Stage 1: This stage involves the treatment of syngas to get rid of impurities and the normalisation of hydrogen to carbon ratio (h2/ CO) under favourable FT synthesis.[28]Stage 2: The second stage known as the FT synthesis produces syncrude by catalytic reaction. Stage 3: The final stage involves refining and product conversion by splitting-up gases, waxes and hydrocarbon liquids and transforming them into finished products.

FIGURE 3: GAS-TO-LIQUID PROCESS

Source: Patel, " Gas Monetisation: A Techno-Economic Comparison of Gas-To-Liquid and LNG", 2005, Glasgow

3. 2. 2 GTL Products

GTL-FT plants produce a vast range of products which are highly clean and environmentally friendly. Diesel produced from GTL is sulphur free with a cetane number greater than 74 as compared to diesel from the refinery with cetane number of 40.[29]Another interesting feature of GTL diesel is its tendency to serve as a blend-stock to upgrade standard diesel under stringent market requirements.[30]It is imperative to note yields from GTL plants can be altered in the Fischer-Tropsch reactor to produce high quality products for the petroleum market such as diesel fuels (C14-C20), Naphtha

(C5-C10), LPG (C3-C4) , kerosene / jet fuel (C10-C13) and lubricants (> C50) .[31]GTL naphtha is low in sulphur with high paraffinic (95%) content suitable for the production of ethylene and a feedstock for cracking ethylene used in the plastic industry.[32]GTL facilities are not only constrained to the production of middle petroleum distillates but can be modified to increase the growth of hydrocarbon chains to produce other valuable products. [33]Products produced under this condition include normal paraffin's (cutting fluids, auxiliary chemicals, plasticizers), synthetic lubricants (Compressor oils, grease, motor oils. Hydraulic fluids), paraffin wax (printing inks, cosmetics, coatings and pharmaceutics) and mixed paraffin's (insecticides, drilling fluids, solvents for paints etc.)[34]

FIGURE 4: CONVENTIONAL REFINED BARREL VERSUS GTL-FT BARREL

Source: Genovese et al., " GTL TECHNOLOGY AND IT'S ROLE IN THE WORLD ENERGY MARKETS'' 2004-2005

3. 2. 3 Prospective Market for GTL Products

Even though GTL is new in the hydrocarbon industry, a good number of oil companies are gingered to pursue the technology. The demand for GTL products such as diesel fuel is on the rise especially in the transportation sector due to the environmental advantages it offers.[35]Therefore, GTL diesel is regarded as panacea to stringent environmental issues in the transportation fuel sector. The market potential for GTL diesel is enormous because it can be added to conventional diesel to minimise its sulphur concentration.[36]It is worthy to note, products from GTL do not entail long term sales and purchase agreements thus can be traded in the open market.

[37]On the International market, GTL diesel and conventional diesel from the refinery command the same price.[38]It is anticipated that GTL diesel will attract a higher price in the future due to its attributes. GTL fuels have proven to work smoothly in already existing engines designed to meet standard diesel requirements.[39]This is normally not the case for other substitute fuels. According to IEA World Energy Outlook 2006, market for GTL will rise from 8 bcm (0. 77 bcf/day) to 199 bcm (19. 25 bcf/day) by 2030. This will give rise to world-wide demand for gas and the need to increase production of liquid fuel.[40]In a related development, products from GTL anticipated to increase to 1. 1 million bb/d by year 2030 and will further increase to 2. 6 million bb/d in times of high oil prices.[41]The outlook signifies that GTL will grow rapidly in the coming years.

3. 2. 4 Economic Viability of GTL Plants (Capital Cost)

The capital cost of operating a GTL plant ranges from $ 25, 000 to $45, 000 (2004 dollars) per barrel dependent on the site of operation and production capacity of the plant.[42]The capital cost of production is gradually reducing from $100, 000 per barrel.[43]Efforts at reducing the capital cost of production include a reduction in the syngas reformers, Fischer-Tropsch reactors and reducing the size of air separation units.[44]Another option to reduce capital cost is by reducing the quantity of cobalt and other valuable metals that serve as catalyst. The ultimate aim of the GTL industry is to reduce capital cost below $20, 000 per barrel, but increase in prices of steel other factors of production is making the achievement of such a goal more challenging. The operating cost of a conventional petroleum refinery is about $15, 000 per barrel per day. A GTL plant with 34, 000 barrels per day

capacity is approximately comparable to a refinery with 100, 000 barrels per day capacity.[45]A GTL plant processing 1 BSCFD is likely to produce 100, 000 BPD of GTL products dependent on the technology used.[46]The capital cost estimated to run such a technology is about $2. 5 billion. The emergence of new technologies is driving the capital expenditure and of low.

4. WHY CHOOSE GAS TO LIQUID AS A MONETIZATION OPTION?

This section of the paper considers the economic benefits of GTL as a monetisation option and also makes reference to some countries currently adopting the technology and those in the interim to join.

4. 1 Factors Favourable To GT Technology

Investments in GTL projects are gradually gaining grounds in recent years than it did in the past. This may be due factors favourable to the emerging technology. The drivers attracting the use of GTL technologies in recent times include economic, market potential, strategic and the environment. [47]

41. 1 Environmental Drivers

GTL products are environmentally conducive because they are sulphur free with zero aromatics emissions compared to conventional crude refinery products.[48]Nitrogen oxide and sulphur oxide emissions from GTL facilities are minimal (21% to 41% reduction) compared to an oil refinery as a result of the purging process involved in the production of its products.[49]A study undertaken by PricewaterhouseCoopers revealed that products from GTL plants offer considerable air quality.[50]An environmental impact

assessment and tank-to- wheel health study was conducted by the Institute for environmental using data from vehicle emissions also yielded similar results.[51]GTL products have a higher cetane number (75-80) thus produce less waste during combustion as against a refinery fuel with cetane number (45-50).[52]This view is supported by a study conducted by Shell and ConocoPhillips which concluded that GTL facilities produce less solid and hazardous waste of about 40%.[53]A major environmental driver for GTL technology is the fight for lighter, low sulphur, and clean- burning fuels and the U. S 1992 Energy Policy Act which considers GTL an " alternative fuel'' from natural Gas.[54]

TABLE 1: COMPARISM OF GTL AND CONVENTIONAL FUEL EMISSIONS

EMISSIONGTL DIESEL FUEL g/kw-hrConventional Diesel Fuel g/kw-hrCarbon Monoxide (CO)0. 670. 94Hydrocarbons (HC)0. 210. 25Particulate Matters (PM)0. 080. 15Nitrogen Oxides (NOX)6. 037. 03Source: Al-Shalchi, " Gas to liquids Technology." (2006)

4. 1. 2 Economic Drive

The transportation cost for GTL is cost effective as compared to the transportation cost of natural gas.[55]For instance, the investment requirement to lay a pipe line (46 to 60 inches) over a distance of 1000km is about $1-$ 1. 5 billion dollars.[56]The Alliance Gas pipeline separating US and Canada over a distance of 3686 km was approximately US$3 billion.[57]The argument on the anticipation of oil peaking in some regions has driven the need to promote GTL technology as a monetisation option for

natural gas.[58]Volatility of crude prices and high refining cost has shifted attention for greater interest into GTL technology.[59]

4. 1. 3Market Drive

Global demand for clean fuel to reduce CO2 , GHG and other environmental challenges has created the desire for GTL technologies due to its environmental advantage.[60]According to the world energy outlook 2002, global demand for GTL gas is projected to hit 170 109 m3 by 2030.[61]The discovery of global gas reserves projected to be about 175 (tcf) and nations effort of eliminating gas flaring has provided a new age for GTL as a monetization option.[62]

5. COUNTRY EXPERIENCES IN THE USE OF GTL TECHNOLOGY

Mossgas in South Africa uses the Fischer-Tropsh Gas-to-liquid technology to produce very authentic environmentally friendly and sulphur-free fuel products in the leading GTL plant in the world.[63]The plant began production in 1993 and produces 22, 500 B/D of GTL finished products from the use of natural gas. Products from the GTL facility comprise diesel, kerosene, petrol, LPG, fuel oil and anhydrous alcohols used in solvent blends, de-icing, thinner for paint formulation and windscreen detergents. Shells GTL plant operation in Bintulu, Malaysia transforms natural gas into synthetic high quality oil products which are colourless and paraffinic.[64]The GTL facility converts 100MM SCFD (million standard cubic feet per day) of natural gas into intermediate extracts of kerosene, gasoil and Naphta. The GTL facility in Bintulu also produces detergents, waxes, feedstocks, lubricant feedstocks, drilling based fluids and solvent feedstocks useful for domestic

and industrial use.[65]Pearl GTL plant in Qatar is emerging to become the world’s dominant producer of GTL products. The facility can boast of a production capacity of about 14000 barrels per day and capable of producing 120, 000 barrels of oil from ethane and natural gas.[66]In 2011, the facility made its first commercial sale of GTL Gasoil and hopes to become a major player in the natural gas industry in the future after resuming full operation.[67]Nigeria is to benefit from a Sasol Chevron Joint Venture GTL plant with a 34, 000 B/D capacity to process 300 MMSCFD of natural gas into 10, 800B/D of naphtha, 1, 000 B/D of LPG and 22, 300 of clean diesel fuel.[68]

TABLE 2: EXISTING GAS TO LIQUID PROJECTS

Location

Operator

start-up

Capacity

(bbl. /d)

Sasolburg, South AfricaSasol19555, 600Mossel Bay, South AfricaPetroSA199236, 000Bintulu, MalaysiaShell199314, 700RasLaffan, QatarOryx GTL200634, 000RasLaffan, QatarShell2011140, 000Escravos, NigeriaChevron201334, 000Source: Adair&Hobbs, " Gas-To-Liquids Plants Offer Great ROI ’’2012

5. 1 EXPECTED BENEFIT OF GTL TO GHANA

The prospect of GTL technology as a monetization option for gas is promising. This is as a result of its enormous benefits to the global demand for cleaner and quality fuel. From the study, GTL products have proven to be

environmentally safe and of high quality standards with low carbon dioxide emissions. GTL plants are noted for the production of high quality premium fuels, lube base stocks and petrochemical naphtha. These products can be very beneficial to the transportation, industrial and domestic sectors of the economy. The production of diesel fuel from a GTL plant is significantly more energy efficient in terms of low cost and reduced carbon dioxide emission as compared to a typical diesel fuel produced from a conventional refinery. The better quality of GTL-FT diesel would contribute immensely to the global quest in ensuring environmental sustainability. The production of LPG from the GTL plant will aid in meeting the high demand for LPG in the transportation sector and for domestic use. Pressure steam from the GTL plant can be used for electricity generation to support already existing hydroelectric power plant in Akosombo. The project when taken on board will save the nation foreign exchange from gas imports from N-gas in Nigeria. Export of GTL-FT products would provide a source of foreign exchange to the nation. The project will provide employment opportunities as well as infrastructure development.

6. CONCLUSION

From the study, GTL technology has proven to be a key player in the natural gas industry. Global fight against Co2 emissions and promotion of the millennium development goal of ensuring environmental sustainability by 2015 is at the heart of most nations and for that much Ghana. The economic and environmental benefits of GTL plants globally cannot be over emphasised. This is evident from countries already operating GTL plants and the economic gains attached to them. Ghana being a " green-horn’’ in the oil

and gas industry with considerable gas reserves and additional new oil field discoveries has the comparative advantage to monetise its gas for economic growth. Even though GTL-FT technology is capital intensive and might pose a hindrance to the Ghanaian economy, it may be considered in the future as a monetisation option for natural gas owing to the numerous benefits associated with GTL technology and the prospects available to the Ghanaian economy.