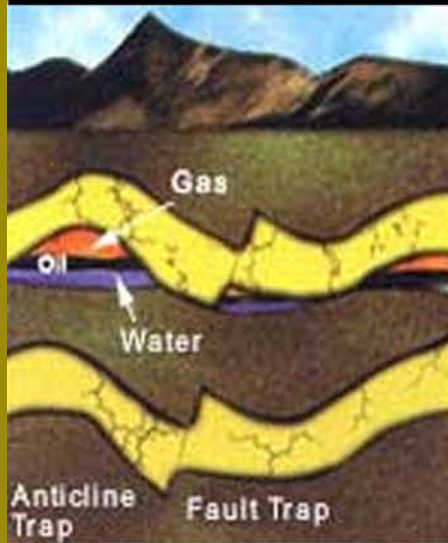


GUIDE TO NATURAL GAS IN GHANA

FIRST EDITION

BY THE RESOURCE CENTRE FOR ENERGY
ECONOMICS AND REGULATION (RCEER)



August 2006

Guide to Natural Gas in Ghana

First Edition

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* RCEER would like to pay tribute to the memory of Emmanuel Quaye-Foli who contributed significantly to Part II of this document before he passed away suddenly and unexpectedly in May 2006.

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ACRONYMS

BC	Before Christ
Bcf	Billion Cubic feet
BOO	Build-Own-Operate
BOST	Bulk Oil Storage and Transportation Company
Btu	British thermal unit
CC	Combined Cycle
CEB	Power generator company jointly owned by Togo and Benin
CEE	Center for Energy Economics
CFC	Chlorofluocarbon
CNG	Compressed Natural Gas
CRE	Commission Regulador de Energia
DME	Diethyl ether
EC	Energy Commission
E&D	Exploration and Development
EF	Energy Foundation
EFA	Economic and Financial assessment
EFS	Engineering Feasibility Study
ELPS	Escravos-Lagos Pipeline System
ENARGAS	Ente Nacional Regulador del Gas
EPC	Engineering Procurement Construction
FERC	U.S. Federal Energy Regulatory Commission
FID	Final Investment Decision
GPA	Gas Purchase Agreement
GDP	Gross Domestic Product
GSA	Gas Transportation Agreement
GTL	Gas to Liquid Technology
GNPC	Ghana National Petroleum Corporation
IEA	International Energy Agency
IPA	International Project Agreement
ISSER	Institute of Statistical, Social and Economic Research
LDCs	Local Distribution Companies
LNG	Liquefied Natural Gas
MMSCFD	Million standard cubic feet per day
N-Gas	Collective gas sellers –Shell, Chevron, NNPC
NGC	Nigeria Gas Company
NGL	Natural Gas Liquids
NGVs	Natural Gas Vehicles
NNPC	Nigeria National Petroleum Corporation
NYMEX	New York Mercantile Exchange
OC	Operating Cost
OFFER	Office of Electricity
OFGAS	Office of Gas
OFGEM	Office of Gas and Electricity Markets
OTC	Over-the-counter market
PDP	Pipeline Development Plan
PNDC	Provisional National Defence Council
PSI	Pounds per square inch

PUC	Public Utility Company
PURC	Public Utilities Regulatory Commission
PEMEX	Petroleos Mexicanos
PVC	Poly Vinyl Chloride
RCEER	Resource Centre for Energy Economics and Regulations
RD&D	Research Development and Demonstration
ROR	Rate of Return
ROW	Right of Way
SC	Single Cycle
SMC	Supreme Military Council
SME	Small and Medium Enterprise
SPDC	Shell Petroleum Development Company
Tcf	Trillion cubic feet
TOR	Tema Oil Refinery
TPA	Third Party Access
TGN	Transportadora del Gas Norte
TGS	Transportadora del Gas Sur
VALCO	Volta Aluminium Company Limited
VRA	Volta River Authority
WAGP	West African Gas Pipeline
WAGPA	West African Gas Pipeline Authority
WAGPC	West African Gas Pipeline Company
WEC	World Energy Council
YPF-A	Yacimientos Petroliferos Fiscales-Argentina

PREFACE

This 'Guide to Natural Gas in Ghana' is published by the Resource Centre for Energy Economics and Regulation (RCEER). The Resource Centre was established as a collaborative initiative by the PURC, Energy Commission, Energy Foundation, Institute of Statistical, Social and Economic Research (ISSER), the Ministry of Energy and the Ministry of Justice. The Resource Centre which is based at the Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, has been envisaged as a centre of excellence for collating and disseminating information and for research work in energy and regulatory economics as well as building capacity and improving skills in the energy and regulatory economics sectors.

The guide is published for two key reasons: first, the guide will provide comprehensive facts on Ghana's natural gas sector. Secondly, it was envisaged that the process of putting this guide together will promote greater collaboration between RCEER and all its stakeholders. RCEER seeks to collect, store, process and disseminate data and knowledge on the energy sector; conduct research to support energy sector development and governance; develop teaching materials for both academic and professional audiences; and educate the public on energy related issues.

This 'Guide to Natural Gas in Ghana' has two parts. Part I discusses the nature and composition of natural gas, the processes of natural gas production, transportation, regulation, marketing and consumption. This part also looks at natural gas utilisation strategies, natural gas and the environment and the prospects of the natural gas industry.

Part II of the guide focuses mainly on natural gas in Ghana, its sources, consumption patterns, and the general effects of natural gas and other sources of energy on the economy of Ghana. It also traces the history of natural gas exploration in Ghana by considering actors, regulatory institutions, policy issues and review reports. This part of the guide also focuses on the entire process of the development of the West Africa Gas Pipeline (WAGP).

Following a lot of consultation, considerable information and data have been assembled for the guide. The guide has been prepared to meet the needs of policy makers, practitioners, academics, media practitioners and the general public. Additionally, the guide serves as easy reference material for many who would ordinarily find it difficult to gain access to such information.

A number of individuals and organisations have contributed immensely towards making this publication possible. We express our appreciation to USAID which funded the project. We also thank Dr. Michelle Michot Foss and Dr. Gurcan Gulen, both of the Center for Energy Economics, University of Texas at Austin, USA to whom we owe a debt of gratitude for the initiative to establish the Centre and for their unstinting technical support for its operations. We are grateful to them for their comments and assistance for this publication.

The stakeholders owe a debt of gratitude to Prof. Ernest Aryeetey, Director of ISSER and Chairman of the Management and Supervisory Committee of the Centre for hosting the institution on its premises and providing the professional personnel for the management and operation of the Centre. We also want to thank Dr. Felix Asante, Coordinator of the Centre for single-handedly nurturing the Centre into a major contributor to research in the field of energy in Ghana and for managing the Centre and its research activities with total commitment and diligence. Our thanks also go to Mrs. Korantema Adi-Dako for her editing work on the publication.

The timing of the publication could not have been more opportune. We await the arrival of gas from Nigeria through the West African Gas Pipeline project with great expectation that Ghana will be better positioned to power its accelerated and sustainable growth agenda with gas from Nigeria on a more cost effective basis than current sources of fuel for our increasingly thermal dominant energy generation mix.

Kwame Pianim
Chairman, Public Utility Regulatory Commission and
Chairman, Advisory Board, RCEER

August 2006

1.0 INTRODUCTION

1.1 Background

Energy is a basic input that is required to meet many basic human needs, particularly heating, motive power (e.g., water pumps, transport etc.) and light. Business, industry, commerce and public services such as modern healthcare, education, and communication are very dependent on access to energy services. In fact inadequate energy services are directly linked to high infant mortality rates, lowered life expectancy, and illiteracy, among several other poverty indicators. In developing countries, inadequate energy services also directly exacerbate the problem of rural to urban migration.

In developing countries, 1.6 billion people lack adequate energy services. Of these, 80% live in the rural areas of South Asia and Sub-Saharan Africa. Increasing energy consumption has long been directly associated with economic growth and improvement in human welfare. Developing countries need more energy to grow their economies at the same rate as developed countries, where through structural changes and increased energy efficiency, energy consumption has been to a great extent decoupled from economic growth.

Around half of all people living in developing countries are dependent on fuel wood, dung and crop residues as their main energy source. Modern energy sources like electricity and petroleum-based fuels generally provide a small part of the energy use of the poor, especially in rural areas, because the poor either find these sources too expensive or energy service providers find such areas unattractive.

Extensive usage of fuel wood or biomass by the poor has many problems. Efficiency rates of fuel wood and biogas utilisation can be as low as 10%. Collection of wood mainly by women and children wastes valuable time that could otherwise be used for engaging in more productive tasks or education. Fuel wood also exacerbates the problem of deforestation with knock-on effects such as loss of wildlife, soil erosion and increased flooding. Burning of firewood and biomass inside households increases the chances of children contracting acute respiratory disorders by up to four times; this indoor air pollution is proving to be more harmful than outside air pollution.

The World Energy Council (WEC) forecasts that primary energy demand for developing countries will triple from its present state and constitute two thirds of total global requirements by 2050. As these economies develop over the decades, demand for energy is expected to increase considerably. Apart from meeting household needs for adequate energy supply, there is growing energy demand for services such as water supply, sanitation, healthcare, education, for productive activities such as agriculture, and for the development of small and medium enterprises (SMEs).

Historically, the main sources of financing energy projects in developing countries have included governments and multilateral institutions; however, these sources have fallen short of the rising needs in most places. In recent decades, the prospect of growing energy demand in developing countries has continued to pose serious challenges to governments and international donor agencies, as governments have lacked the resources to invest in necessary infrastructure, and multilateral donor agencies have limited their funding for projects such as hydroelectric dams and similar energy infrastructure. Many countries therefore started to implement reform policies, with guidance and pressure from donor agencies, in order to attract private

investors, especially from the early 1990s. These reforms generally included but were not restricted to the privatisation of publicly-owned utilities and the removal of subsidies. However private sector participation faded after an initial period of excitement. In most places, the political nature of energy services, a lack of experience and familiarity with private delivery and regulation of these services, as well as cronyism and corruption, contributed to the failure to attract private capital after a few bad experiences.

By their very nature, energy investments can be very risky; as such, investors prefer places where the uncertainties are minimised. Governments have the sole authority and responsibility to ensure that such an enabling environment is created.

Additionally, other considerations are required for optimum energy choices in developing countries. These include affordability of energy, ease of access and local capacity to absorb, use and maintain technology, since not all technology is adaptable and cost effective. Energy choices worldwide are informed by the impact on those whose livelihoods depend on the processing and sale of traditional fuels, local preferences, attitudes and perceptions and knock-on benefits such as the creation of jobs associated with supporting industries.

In Ghana, the pattern of energy demand over the years matches energy patterns for most developing countries, with biomass and petroleum products consumption being the main sources of energy. In 1985, wood fuels, including charcoal, accounted for about 66% of total energy consumption as compared to about 67.3% in 1996. In 1985, petroleum products and electricity accounted for 25.6% and 8.3% respectively while the figures for 1996 were 19.0% and 13.7%. In 2000, a survey conducted by Ghana's Energy Commission established fuel wood consumption at around 60%, petroleum products at 35% and electricity at 10%. These trends are indicative of a high and persistent dependency on wood fuel or biomass.

At the sectoral level, a study conducted for the Energy Commission by Akoena et al. (2001) revealed that households account for about 60% of total energy demand, the transport sector 28%, industry 9% and services including agriculture 3%. Thus the household and transport sectors alone consumed almost 88% of total energy in 2000.

Upon the completion of the West Africa Gas Pipeline (WAGP), Ghana will start receiving significant amounts of natural gas, primarily to be used in power generation and by industry, which may get more developed due to the availability of natural gas. Eventually, households may be able to benefit from this fuel for cooking, heating water and other uses. Natural gas will be a new source of energy in Ghana's portfolio. As such, it should help the country diversify its energy supply sources and reduce the demand for wood and biomass as well as imported petroleum products. A pipeline infrastructure will be developed gradually to deliver natural gas to users. The investments necessary will be based on the regulatory environment created by the Ghanaian government and its various agencies, including the Ministry of Energy, the Public Utilities Regulatory Commission (PURC) and the Energy Commission (EC).

1.2 Objectives and rationale

The rationale of this guide is to offer a single source of reference on fundamental information related to production, transmission, distribution and consumption of natural gas, a new fuel in Ghana. Accordingly, the objectives include:

1. Collating scattered information and data on natural gas for use by politicians, policy makers, regulators, academicians, research institutions, the media and the general public;
2. Creating awareness through presentations of the multiple and safe uses of and environmentally friendly nature of natural gas;
3. Providing the basic text material for general education and teaching; and
4. Providing the basis for further research and outreach.

1.3 Structure

After the introduction, the guide is divided into Part I and Part II. Part I considers the nature and composition of natural gas, the processes of natural gas production, transportation, regulation, marketing and consumption. This part also looks at natural gas utilisation strategies, natural gas and the environment and the prospects of the natural gas industry.

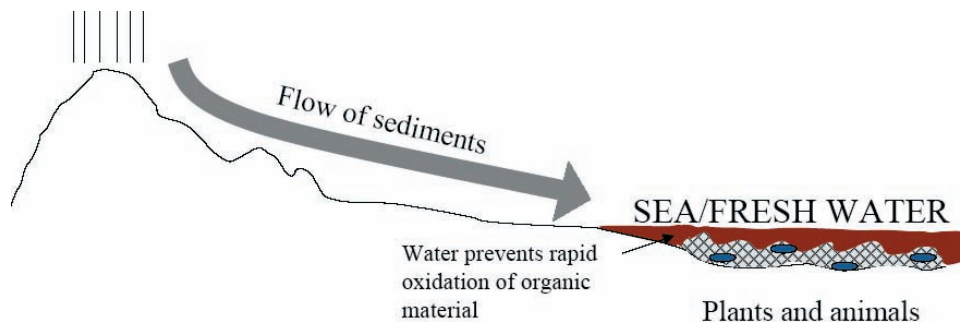
Part II of the guide focuses mainly on natural gas in Ghana, its sources, consumption patterns, and the general effects of natural gas and other sources of energy on the economy of Ghana. It also traces the history of natural gas exploration in Ghana by considering actors, regulatory institutions, policy issues and review reports. This part of the guide also focuses on the entire process of the development of the West Africa Gas Pipeline (WAGP) from its inception, achievements to date, setbacks and policy issues. Lastly, it focuses on issues pertaining to gas utilisation strategies in Ghana, environmental impact assessment and the general socio-economic impact of WAGP on the energy sector of Ghana.

PART I

2.0 FUNDAMENTALS OF NATURAL GAS ^{1,2}

2.1 Nature, origin and composition of natural gas

Natural gas is a fossil fuel like coal and crude oil (or petroleum). The prevailing scientific theory is that fossil fuels were formed millions of years ago when plants and tiny sea animals were buried by sand and rock (see graphic below). Layers of mud, sand, rock and plant and animal matter continued to build up until the pressure and heat from the earth turned them into coal, petroleum and natural gas. Therefore natural gas, like crude oil, is usually found in deep underground reservoirs formed by porous rock (see next section for details on underground reservoirs).



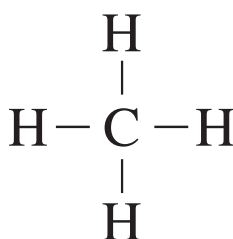
Sometimes it occurs by itself and is produced alone (non-associated gas), or it comes to the surface with crude oil (associated gas). Temperature increases as we go deeper underground. More oil than natural gas is produced closer to the surface (lower temperatures) and more natural gas than oil is created deeper underground (higher temperatures). Somewhere in between (one to two miles below ground) natural gas can be found associated with crude oil. Deeper deposits, very far underground, usually contain primarily natural gas, and in many cases, pure methane.

Another way for methane to form is organic transformation caused by bacteria or microorganisms. A prime example of this type of methane formation is landfill gas. Landfills for municipal or agricultural waste disposal around the world produce significant amounts of natural gas and there are now facilities that capture this gas to generate electricity or for other uses.

¹ To visualise some of the concepts that are described please visit www.adventuresinenergy.org. There is an interactive tool that allows the reader to learn about oil and natural gas characteristics, their production, transportation and uses in simple language.

² The narrative in this section is based on the information available at the www.naturalgas.org site, various teaching materials and publications of the Center for Energy Economics, the Bureau of Economic Geology, University of Texas at Austin, and research by RCEER.

Natural gas is a combustible, gaseous mixture of simple hydrocarbon compounds. Hydrocarbons have molecules that are combinations of hydrogen and carbon atoms. Natural gas is composed almost entirely of methane, but does contain small amounts of other gases, including ethane, propane, butane and pentane. These other gases are also called natural gas liquids, or NGLs. Methane is composed of a molecule of one carbon atom and four hydrogen atoms. The NGL molecules have more carbon and hydrogen atoms and hence they are heavier than methane. When natural gas contains almost pure methane, it is called 'dry' gas; when it contains some of the other gases (NGLs), it is called 'wet' gas.



Methane Molecule

LNG is made up of mostly methane. The liquefaction process requires the removal of the non-methane components like carbon dioxide, water, butane, pentane and heavier components from the produced natural gas. CNG is natural gas that is pressurised and stored in welding bottle-like tanks at pressures up to 3,600 psig. Typically, CNG is the same composition as pipeline quality natural gas. NGLs are made up mostly of molecules that are heavier than methane like ethane, propane, and butane. LPG is a mixture of propane and butane in a liquid state at room temperatures. GTL refers to the conversion of natural gas to products like methanol, diethyl ether (DME), middle distillates (diesel and jet fuel), specialty chemicals and waxes.

Source: Center for Energy Economics, University of Texas (www.beg.utexas.edu/energyecon/lng)

When burned, methane provides a large amount of energy. It is the cleanest burning fossil fuel, producing primarily carbon dioxide, water vapour and small amounts of nitrogen oxides. These characteristics explain the relative popularity of natural gas among fossil fuels.

Natural gas can be measured by volume or by its heat or energy content. At normal temperatures and pressure, natural gas volume is measured in cubic feet or cubic metres around the world. There are about 35 cubic feet in one cubic metre. In terms of its energy content, natural gas is commonly measured in British thermal units (Btu). One Btu is the amount of energy that will heat one pound of water by one degree fahrenheit. It is relatively easy to transfer between volumetric and energy measures: one cubic foot of natural gas contains about 1,000 Btus. For billing purposes, companies that deliver natural gas also use 'therm', which is equivalent to 100,000 Btus or about 100 cubic feet of natural gas.

2.2 Finding, producing and delivering natural gas

The process of getting natural gas out of the ground and to consumers is a complicated one. This section provides an overview of the processes that allow the natural gas industry to explore for and extract their product out of the ground, and transform it into the natural gas that is used in power generation, homes and industries. Exploration, extraction and production activities are very similar to those for crude oil, or petroleum. In fact, oil and natural gas are often found and produced together; in which case natural gas is called associated natural gas. However, transportation, storage, distribution and use of natural gas are quite unique to the industry.

Exploration

The practice of locating natural gas and petroleum deposits has been transformed dramatically since the early 1980s with the advent of technologies such as multi-dimensional seismic data collection and analysis, and horizontal drilling of production wells. In the early days of the industry, the only way of locating underground natural gas deposits was to search for surface evidence of these underground formations. The search for natural gas deposits required looking for seepages of oil or gas emitted from underground deposits. However, this turned out to be a very inefficient and difficult exploration process because only a small proportion of petroleum and natural gas deposits actually seep to the surface.

Technology has allowed for an incredible increase in the success rate of locating natural gas reservoirs. Geologists and geophysicists use technology, and their knowledge of the properties of underground natural gas deposits, to gather data that can later be interpreted and used to make educated guesses as to where natural gas deposits exist. Note that, despite technological advances these are still “guesses,” this is because the process of exploring for natural gas deposits is rife with uncertainty and trial-and-error, simply due to the complexity of searching for something that is often hundreds, and often thousands, of metres below ground.



Figure 1 - Anticline and fault traps

The exploration for natural gas typically begins with geologists examining the surface structure of the earth, and determining areas where it is geologically likely that petroleum or gas deposits might exist. This is called a geological survey. In the mid 1800s, geologists discovered that anticlinal slopes had a higher prospect of containing petroleum or gas deposits. These anticlinal slopes are areas where the earth has folded up on itself, forming the dome shape trap that is conducive to formation of oil and gas reservoirs.³ There are three other types of traps that also allow for hydrocarbon reservoirs to form: traps created by fault lines (also depicted in Figure 1), traps that are created by salt domes and stratigraphic traps.

Once there are geological clues for various traps visible on the surface, seismic studies are carried out to investigate whether these traps also exist underground. Seismic technology was first used in 1855 to record earthquakes. By the 1920s, the petroleum industry had started using the technology to identify underground formations. Seismic analysis includes the sending of sound waves underground and recording the waves that bounce back from various structures. Until the 1980s, the industry had been able to record seismic data only in two dimensions, which limited the ability to accurately locate potential reservoirs. Multidimensional seismic data now allows oil and gas companies to locate reservoirs with much greater accuracy and hence avoid the costs of drilling dry holes.

³ The picture depicting anticline and fault traps is taken from the American Petroleum Institute website (<http://www.classroom-energy.org/teachers/petroleum/index.html#>).

It must be noted, however, that despite the positive impact of multidimensional seismic data and many other technological advances, the only way of ensuring that a petroleum or natural gas reservoir exists is to drill an exploratory well. Geologists and geophysicists can make their best guesses based on geologic surveys and seismic studies as to the location of reservoirs, but they cannot be certain until an exploratory well is drilled and oil or natural gas starts flowing.

Extraction

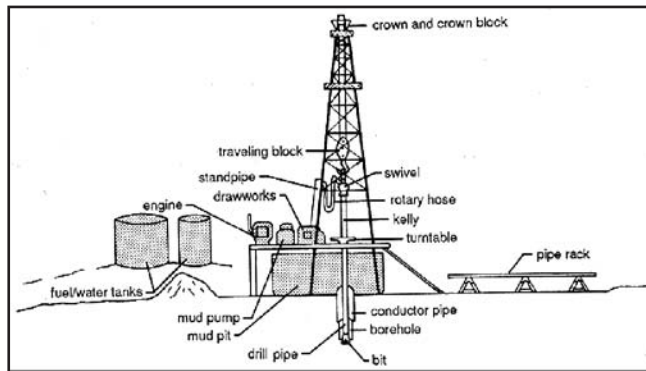


Figure 2 - Schematic of an onshore drilling rig

Once a potential natural gas deposit has been located by a team of exploration geologists and geophysicists, it is up to a team of drilling experts to actually dig down to where the natural gas is thought to exist. The industry has developed a number of innovations and techniques which both decrease the cost and increase the efficiency of drilling for natural gas (see schematic of an onshore drilling rig in Figure 2). The advance of technology has also contributed greatly to the increased efficiency and success rate for drilling natural gas wells.

The decision of whether or not to drill a well depends on a variety of factors. The economic characteristics of the potential natural gas reservoir are some of the most important considerations. It costs a great deal of money for exploration and production companies to search and drill for natural gas, and there is always the inherent risk that no natural gas will be found.

The exact placement of the drill site depends on a variety of factors, including the nature of the potential underground rock formation to be drilled, the characteristics of the subsurface geology, reservoir pressure and temperature, flow rates and the depth and size of the target deposit. There are also significant differences between onshore drilling and offshore drilling, which may require special techniques and equipment (see the picture of offshore drilling rig in Figure 3).



Figure 3 - Offshore drilling rig

After the geophysical team identifies the optimal location for a well, it is necessary for the drilling company to ensure that it completes all the necessary steps to ensure that it can legally drill in that area. This usually involves securing permits for the drilling operations, establishment of a legal arrangement to allow the natural gas company to extract and sell the resources under a given area of land, and a design for gathering lines that will connect the well to the processing plant or a pipeline. There are a variety of potential owners of the land and mineral rights of a given



Figure 4 - Onshore drilling

area. In almost every country, the owner of natural gas is the state, or the nation. A significant exception is the United States where most but not all reserves (especially onshore, see Figure 4) are owned by individual landowners. Offshore reserves of natural gas are usually owned by the state, even in the United States.

Once the production site is fully developed and natural gas from the field starts flowing at acceptable rates, the part of a production well visible on the surface will be a simple combination of pipes, valves and pressure gauges (see Figure 5 below).

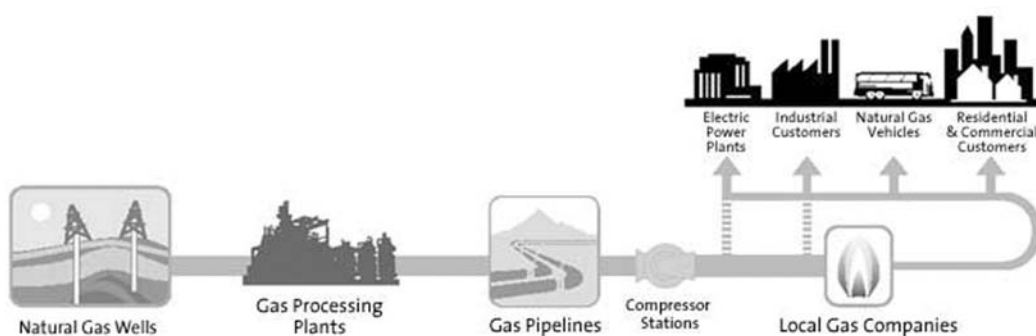


Figure 5 - A fully developed natural gas production site

Delivery of natural gas

In order to deliver the natural gas that has been extracted from the ground to consumers, several steps are necessary. First, natural gas may need to be separated from oil if they occur together. Second, impurities in natural gas need to be removed before a form of natural gas that can be used by consumers can be placed in pipelines. This is known as processing. Natural gas from the producing fields is carried to the processing plants via gathering pipelines. After processing, natural gas is put into the large diameter pipelines that are used to transport it over long distances. Finally, smaller diameter pipelines are laid to bring natural gas to consumers.

Processing

Once a well has been drilled, and the presence of commercially viable quantities of natural gas has been verified, the next step is actually lifting the natural gas out of the ground and processing it for transportation. Processing is only needed if the natural gas stream includes impurities, such as sulphur, or quantities of other molecules like propane and ethane or other gases like carbon dioxide. While some of the needed processing can be accomplished at or near the wellhead, the complete processing of natural gas takes place at a processing plant, usually located in a natural gas producing region. The extracted natural gas is brought to these



Figure 6 - Natural gas processing plant

processing plants through a network of gathering pipelines. The gathering system consists of low pressure, low diameter pipelines that transport raw natural gas from the production wells to the processing plant. If natural gas from a particular well has high sulphur and carbon dioxide contents (sour gas), a specialised sour gas gathering pipe must be installed. Sour gas is extremely corrosive and dangerous, thus its transportation from the wellhead to the sweetening plant must be done carefully. In addition to processing done at the wellhead and at centralised processing plants, some final processing is also sometimes accomplished at 'straddle extraction plants' or compressor stations (see Figure 6), located on major pipeline systems.

Although the processing of natural gas is not as complicated as the processing and refining of crude oil, it is equally necessary to process it before its consumption by end users. Natural gas, as it exists underground, is not exactly the same as the natural gas that can be consumed. Natural gas that can be used is almost entirely methane. Natural gas as found underground usually comes associated with a variety of other compounds and gases (for example, natural gas liquids, as described previously as well as oil and water, which must be removed. Natural gas transported through pipelines must meet purity specifications to be allowed in the pipeline system, so most natural gas processing occurs near the well before entering the transportation pipeline network.

Natural gas processing consists of separating all of the various hydrocarbons and fluids from the pure natural gas, to produce what is known as 'pipeline quality' dry natural gas which is entirely, or almost entirely, methane.⁴ There are regulations in terms of quality of the gas that can be carried in a pipeline system. While the ethane, propane, butane, and pentane (NGLs) must be removed from natural gas, this does not mean that they are all 'waste products'. In fact, these NGLs can be very valuable by-products of natural gas processing; they are sold separately and have a variety of different uses, including enhancing oil recovery in oil wells, providing raw materials for oil refineries or petrochemical plants, and as sources of energy. Nor are impurities such as sulphur and carbon dioxide waste products. Sulphur is used in fertilisers and many other compounds. Carbon dioxide is used for enhanced oil recovery, food processing, and many other applications.

Transportation

The efficient and effective movement of natural gas from producing regions to consumption regions requires a pipeline transportation system.⁵ In many instances, natural gas produced from a particular well will have to travel a great distance to reach its point of use, such as the 900-km West Africa Gas Pipeline (WAGP), bringing natural gas from Nigeria to Ghana along with Benin and Togo. As

⁴ The picture of a natural gas processing plant in Figure 6 is provided by Duke Energy Transmission Canada and taken from http://www.naturalgas.org/naturalgas/processing_ng.asp.

⁵ The picture of pipeline construction in Figure 7 is provided by Duke Energy Transmission Canada and taken from <http://www.naturalgas.org/naturalgas/transport.asp>.

consumption levels increase, the transportation system becomes a complex network of pipelines, designed to quickly and efficiently transport natural gas from



Figure 7 - Pipeline construction for transporting natural gas

production fields to areas of high natural gas demand. The pipes used for transportation range between 16 and 48 inches in diameter and are usually produced out of steel. They are coated with special materials to protect against corrosion and rusting.

Natural gas is pressurised in order to flow in these pipelines over long distances. The pressure is maintained at compressor stations. Depending on the length of the pipeline and the desired level of natural gas flow, compressor stations can

be placed along the pipelines every 40 to 100 miles (about 65 to 160 km). At these stations, natural gas is compressed by a turbine, motor or engine, which is usually powered by natural gas or electricity. There will also be metering stations at certain intervals to measure the flow of natural gas in the pipeline system.

Storage

Transportation of natural gas is closely linked to its storage. Natural gas can be stored for an indefinite period of time. The exploration, production, and transportation of natural gas take time, and these activities are not always in line with fluctuations in demand for natural gas.

The consumption of natural gas can fluctuate especially seasonally, if heating is a primary use of natural gas, but it can also fluctuate with changes in electricity demand. When the natural gas that is produced is not needed

Box 1

Commercial value of storage – the case of the US

Historically, when natural gas was a regulated commodity, storage was part of the bundled product and services sold by the pipelines to distribution utilities for operational requirements. This all changed in 1992 with the introduction of the Federal Energy Regulatory Commission's (FERC) Order 636, which opened up the natural gas market to deregulation. Essentially, this meant that natural gas storage is now available to anyone seeking storage for commercial purposes or operational requirements. Storage used to serve only as a buffer between transportation and distribution, to ensure that adequate supplies of natural gas were in place for seasonal demand shifts, and unexpected demand surges. Now, natural gas storage is also used for commercial reasons; storing gas when prices are low, and withdrawing and selling it when prices are high, for instance. The purpose and use of storage has been closely linked to the evolution of commercial natural gas services. There is about 4 trillion cubic feet (Tcf) of working gas storage capacity in the United States, a roughly four-fold increase since the 1960s

right away, it can be injected into underground storage facilities, such as depleted oil and gas reservoirs, aquifers or salt caverns, where available, or can be kept as liquefied natural (LNG) in above ground tanks. These facilities can be located near market centres that do not have a ready supply of locally produced natural gas or at the producing regions before entry into the pipeline network (primarily because these regions are most likely to have depleted reservoirs). Natural gas in storage also serves as insurance against any unforeseen accidents, natural disasters, or other occurrences that may affect the production or delivery of natural gas. For example, the hurricanes in the Gulf of Mexico in 2005 caused production facilities to shut down, which forced local distribution companies (LDCs) and others to use natural gas from storage facilities to meet demand. Similarly, when Russia cut the natural gas flow to Ukraine because of the price dispute between the two countries in January 2006, Ukraine and some countries in Europe which received natural gas from Russia through pipelines that went through Ukraine had to resort to natural gas from storage, albeit for only a day or two. Storage can also be critical in natural gas producing areas as a “hedge” against fluctuations in oil prices. In this way, supplies of natural gas that are associated with crude oil production are protected from uncertainties in petroleum markets.

Distribution

While some large consumers (industrial facilities such as aluminum smelters and cocoa processors, commercial establishments such as office buildings and power plants) may receive natural gas directly from high capacity transportation pipelines, most other users receive natural gas from a local distribution company. The LDCs are companies involved in the delivery of natural gas to consumers within a specific geographic area. In the case of Ghana, the first few LDCs are likely to begin with serving all types of customers (industrial, commercial, power plants and any others) in their geographic areas. However it is also necessary for sufficient natural gas demand to exist in a given area to justify the investment in such a distribution network, and large consumers may be needed to secure this level of demand.

Around the world, there are two basic types of local distribution companies: those owned by private investors that are regulated by governmental agencies, and public gas systems owned and operated by either local governments or state (sovereign) pipeline companies.

Local distribution companies typically transport natural gas from delivery points along major pipelines through a large network of small-diameter distribution pipes. Delivery points to LDCs, especially for large municipal areas, are often termed 'citygates' and are important market centres for the pricing of natural gas. Typically, LDCs take ownership of the natural gas at the citygate, and deliver it to each individual customer's user location.

Because of the pipeline infrastructure required to move natural gas to many diverse customers across a reasonably wide geographic area, as well as to maintain the pipes and respond to emergency outages, distribution costs typically make up the majority of natural gas costs for small volume end users. While large pipelines can reduce unit costs by transmitting large volumes of natural gas, distribution companies must deliver relatively small volumes to many more different locations.

Small-diameter pipes are used to bring natural gas from the citygate to individual consumers. The pressure required to move natural gas through the distribution network is much lower than that found in the transmission pipelines and as such local compressor stations are typically much smaller than those used for long distance transportation. While natural gas travelling through transmission lines may be compressed to as much as 1,300 pounds per square inch (psi), natural gas travelling through the distribution network requires as little as 3 psi of pressurisation. The natural gas to be distributed is typically depressurised at or near the citygate, as well as scrubbed and filtered to ensure low moisture and particulate content. In addition, Mercaptan is added; because natural gas is odourless and colourless, the distinct odour of Mercaptan makes the detection of leaks much easier.

Traditionally, rigid steel pipes were used for local distribution but new technology is allowing the use of flexible plastic and corrugated stainless steel tubing. These new types of tubing allow cost reduction and installation flexibility for both local distribution companies and consumers.

Another innovation in the distribution of natural gas is the use of electronic meter-reading systems. Traditionally, in order to bill customers correctly, meter-reading personnel had to be dispatched to record the volumes of natural gas consumed by each customer from their on-site meters. New electronic meter-reading systems are capable of transmitting this information directly to the local distribution company, allowing cost savings for the LDC, which in turn passes these savings along to customers.

New trenching techniques are allowing for the installation of distribution pipes with less impact on the above ground surroundings. Guided drilling systems are used to excavate an underground hole in which the pipe may be inserted, and can lead to significant excavation and restoration savings. This is particularly important in crowded urban settings, where the installation of natural gas distribution pipes can be a major inconvenience for residents and business owners, and also in scenic rural environments.

2.3 Growth of natural gas exploration ⁶

Before there was an understanding of what natural gas was, it posed somewhat of a mystery to man. Sometimes, such things as lightning strikes would ignite natural gas that was escaping from under the earth's crust. This would create a fire which appeared to be coming from the earth, burning the natural gas as it seeped out from underground. These fires puzzled most early civilizations, and were the root of much myth and superstition. One of the most famous of these types of fires was found in ancient Greece, on Mount Parnassus in approximately 1,000 B.C. A goat herdsman came across what looked like a 'burning spring', a flame rising from a fissure in the rock. The Greeks, believing it to be of divine origin, built a temple on the flame. This temple housed a priestess who was known as the Oracle of Delphi, giving out prophecies she claimed were inspired by the flame.

⁶ This section is taken from <http://www.naturalgas.org/overview/history.asp>

These types of springs became prominent in the religions of India, Greece and Persia. Unable to explain where these fires came from, they were often regarded as divine or supernatural. It was not until about 500 B.C. that the Chinese discovered the potential to use these fires to their advantage. Finding places where gas was seeping to the surface, the Chinese formed crude pipelines out of bamboo shoots to transport the gas, where it was used to boil sea water, separating the salt and making it drinkable.

Britain was the first country to commercialise the use of natural gas. Around 1785, natural gas produced from coal was used to light houses, as well as streetlights. Manufactured natural gas of this type (as opposed to naturally occurring gas) was first introduced to the United States in 1816, when it was used to light the streets of Baltimore, Maryland. However, this manufactured gas was much less efficient, and less environmentally friendly than modern natural gas that comes from underground.

Naturally occurring natural gas was discovered and identified in America as early as 1626, when French explorers discovered natives igniting gases that were seeping into and around Lake Erie. The American natural gas industry got its beginnings in this area. In 1859, Colonel Edwin Drake (a former railroad conductor who adopted the title 'Colonel' to impress the townspeople) dug the first well. Drake hit oil and natural gas at 69 feet below the surface of the earth.

Most in the industry characterise this well as the beginning of the natural gas industry in America. A two-inch diameter pipeline was built, running 5 miles from the well to the village of Titusville, Pennsylvania. The construction of this pipeline proved that natural gas could be brought safely and relatively easily from its underground source to be used for practical purposes.

In 1821, the first well specifically intended to obtain natural gas was dug in Fredonia, New York, by William Hart. After noticing gas bubbles rising to the surface of a creek, Hart dug a 27 foot well to try and obtain a larger flow of gas to the surface. Hart is regarded by many as the 'father of natural gas' in America. Expanding on Hart's work, the Fredonia Gas Light Company was eventually formed, becoming the first American natural gas company.

During most of the 19th century, natural gas was used almost exclusively as a source of light. Without a pipeline infrastructure, it was difficult to transport the gas very far, or into homes to be used for heating or cooking. Most of the natural gas produced in this era was manufactured from coal. Near the end of the 19th century, with the rise of electricity, natural gas lights were converted to electric lights. This led producers of natural gas to look for new uses for their product.

In 1885, Robert Bunsen invented what is now known as the Bunsen burner. He managed to create a device that mixed natural gas with air in the right proportions, creating a flame that could be safely used for cooking and heating.⁷ The invention of the Bunsen burner opened up new opportunities for the use of natural gas in America and throughout the world. The invention of temperature-regulating thermostatic devices allowed for better use of the heating potential of natural gas, allowing the temperature of the flame to be adjusted and monitored.

⁷ Methane – natural gas – ignites within a range of 5 to 15% mixture with air. This strong property is important for safe, secure use of natural gas

Without any way to transport it effectively, natural gas discovered before World War II was usually just allowed to vent into the atmosphere, or burnt, when found alongside coal and oil, or simply left in the ground when found alone, or reinjected if produced with petroleum.

One of the first lengthy pipelines was constructed in 1891. This pipeline was 120 miles long, and carried natural gas from wells in central Indiana to the city of Chicago. However, this early pipeline was very rudimentary, and was not very efficient at transporting natural gas. It was not until the 1920s that any significant effort was put into building a pipeline infrastructure. However, it was not until after World War II that welding techniques, pipe rolling and metallurgical advances allowed for the construction of reliable pipelines. This post-war pipeline construction boom lasted well into the 1960s, and allowed for the construction of thousands of miles of pipeline in America.

Once the transportation of natural gas was possible, new uses for natural gas were discovered. These included using natural gas to heat homes and operate appliances such as water heaters and oven ranges. Industry began to use natural gas in manufacturing and processing plants. Also, natural gas was used to heat boilers used to generate electricity. The transportation infrastructure had made natural gas easy to obtain, and it was becoming an increasingly popular form of energy.

In Britain as well, natural gas replaced coal-based gas early in the 20th Century. The Soviet Union expanded its natural gas infrastructure and consumption after the mid-20th century. Natural gas started to become a major fuel in the rest of the world only in the late 20th century, as high oil prices and advances in gas turbines combined to create an environment conducive to natural gas infrastructure development. Discoveries in the North Sea and imports from the Soviet Union allowed most of Europe to develop extensive pipeline networks and increase the use of natural gas for heating, power generation and industrial purposes. Many countries in Latin America have also been expanding their natural gas production and consumption. The transportation of natural gas in liquid form (LNG) permitted countries such as Japan and South Korea to develop natural gas markets despite having no natural gas production of their own. The improving economics of liquid natural gas promises to make more natural gas available from regions that have large reserves for the consuming regions.

2.4 Natural gas as an alternative source of energy

For hundreds of years, natural gas has been known as a very useful substance. The Chinese discovered a very long time ago that the energy in natural gas could be harnessed, and used to heat water. In the early days of the natural gas industry, the gas was mainly used to light streetlamps, and occasionally buildings. However, with much improved distribution channels and technological advancements, natural gas is being used in ways never thought possible.

Natural gas has many applications, commercially, in homes, in industry, and even in the transportation sector. Natural gas and its components are used as raw material to manufacture a wide variety of products, from fibres for clothing, to plastics for healthcare, computing, and furnishings. There are so many different

applications for this fossil fuel that it is hard to provide an exhaustive list of everything it is used for, and no doubt, new uses are being discovered all the time. For example natural gas is considered to be a primary source of hydrogen, with many expectations that hydrogen could constitute the next major energy source.

Around the world, natural gas is used extensively in residential, commercial and industrial applications. In cold regions of the world, such as the U.S. and Europe including Russia, residential use for heating purposes is significant. For example, 55% of American homes use natural gas for heating. The use of natural gas is also rapidly increasing in electric power generation, cooling, and as a transportation fuel. In fact, worldwide, the primary use of natural gas in recent years has been for electric power generation. There have been significant technological advances in gas turbines used for generating electricity, which have increased efficiency and lowered costs. As a result, companies as well as governments have been quite interested in building power plants that use these turbines and burn natural gas, especially where electricity demand has been rising fast and natural gas has been available.

Box 2

Food Processing: Because steam accounts for 60% of the energy used in the food processing industry, an important economic factor is the availability of efficient boilers. The Knouse Food Cooperative in Pennsylvania recently installed a Donlee Technologies' TurboFire® XL boiler. This low nitrogen oxides (or NOx) high-efficiency boiler has enhanced productivity at the cooperative, which processes four varieties of apples as well as peaches, cherries, blueberries, blackberries and raspberries. The natural gas boiler can start up in just 30 to 45 minutes, replacing two older boilers that had taken up to three hours to reach full steam. More consistent steam quality also helps prevent the fruit from becoming too wet during processing.

Steel Production: For almost two centuries, U.S. foundries have used vertical cylindrical furnaces known as "cupolas" to melt iron, using coke as fuel. Depending on petroleum prices, coke can be expensive, and increasingly strict environmental standards add substantially to its cost. A new technology, supplemental firing of the cupola with natural gas, is helping foundries cut costs while increasing productivity. Sulphur from coke can contaminate the iron, affecting product quality and contributing to emission of sulphur oxides and fine particulate matter. Processed natural gas contains no sulphur. The higher combustion efficiency of natural gas reduces the total amount of energy required. Supplemental natural gas firing increases production by up to 30%, and saves up to \$5 per ton of iron produced. In Mexico, the incentives for using natural gas instead of electricity in steel production are mounting because environmental restrictions are tightening and natural gas firing yields higher efficiency and productivity.

Natural gas is currently the fuel of choice for electric power generation around the world. Not only does it emit fewer pollutants than coal or oil products when burned, it is also cheaper and quicker to build gas-fired power plants than other conventional plant types. So, it makes economic and environmental sense to use

natural gas for power generation. In addition, there are significant resources of natural gas around the world that are currently stranded, that is without an immediate way to get value out of them. If there are no local markets for residential heating and industrial consumers are limited, and if there are no export markets within pipeline distance, the easiest way to create a market for natural gas is to use it for power generation.

Nevertheless, power generation is not a direct use of natural gas and thus may not be the most efficient use. Although gas turbines are the most efficient power generation technologies around, there are still losses in the process of converting natural gas to electricity. However, gains continue to be made in the gas turbine efficiencies. In addition, the environmental benefits of using natural gas for power generation are an important consideration. Direct use of natural gas at industrial facilities or at homes would be making use of more of the fuel's heat content. Among the industrial uses are fertiliser plants, petrochemical facilities, and any manufacturing activity with a need for steam such as aluminum smelters.

Newer technologies such as gas-to-liquids (GTL) allow production of clean-burning diesel fuel for transportation. Natural gas can also be used for transportation if it is compressed. Transportation uses of natural gas, though, can still be very expensive, relative to petroleum products like gasoline and if extensive gasoline distribution networks exist. Natural gas for vehicle fuels can be quite competitive where new infrastructure for re-fueling can be built, where air quality restrictions are strong, or if public policies create incentives for natural gas vehicles.

In the absence of a heating season and urbanised population, household use of natural gas will be limited unless alternative applications are available. Natural gas can be used for cooling or for appliances such as clothes dryers. In some locations, natural gas may offer a price advantage or service convenience over other fuels.

However, as discussed before, building and operating a distribution system is expensive. Some households may not be able to afford natural gas made available through these systems. Every customer on the network who does not use and pay for natural gas will cause an increase in the cost of serving others. These considerations must be kept in mind when designing new LDCs.

In the absence of a large industrial, commercial and/or residential base for natural gas, electric power generation offers the best option for getting value out of natural gas and anchoring a market for natural gas. This market can then be expanded by development of industries that can benefit from natural gas and gradual transition to natural gas from other fuels where feasible and economical.

2.5 Natural gas and the environment

Combustion of fossil fuels such as coal, oil and natural gas cause pollutants to be released into the atmosphere; these pollutants may have a negative impact on the environment as well as the health of people living near industrial facilities or power plants burning these fuels. Among these fuels, natural gas is the cleanest because it emits the fewest pollutants.

Table 1
Fossil Fuel Emission Levels
- Pounds per Billion Btu of Energy Input

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulphur Dioxide	1	1,122	2,591
Particulates	7	84	2,744
Mercury	0.000	0.007	0.016

Source: EIA - Natural Gas Issues and Trends 1998

Using natural gas in place of other fossil fuels can help ease a number of environmental concerns - greenhouse gas emissions, acid rain, smog, solid waste and water pollution. When natural gas is burned, it produces virtually no emissions of sulphur dioxide or particulate matter and far lower levels of "greenhouse" gases and nitrogen oxides than such competing sources of energy as oil and coal. In addition, unlike the oil, coal and nuclear processes, the natural gas process produces virtually no solid waste and has much less impact on water quality.

The inherent cleanliness of natural gas when compared with those other fuels, coupled with the high efficiency of natural gas equipment, means that substituting natural gas for the other fuels can help reduce the emission of the air pollutants that produce smog and acid rain and that could exacerbate the "greenhouse" effect.

Although natural gas can be more expensive to purchase than coal, it can help industrial users save on operating costs. Gas units tend to be less complex and thus easier to operate and maintain than other equipment. Since natural gas is distributed by underground pipelines, there is no need to store the fuel on-site. And there is no solid waste or ash to dispose of following an industrial process with gas-fired equipment.

During the past several years, the natural gas industry has developed and commercialised many types of burners with low emissions of nitrogen oxides (NOx) and other emissions reduction technologies (see Box 2 for examples from food processing and steel production).

2.6 Gas utilisation strategy options ⁸

International investor goals have coalesced around the need to “monetise” natural gas production which has no current market outlets, that is, gas which is “stranded” or uneconomic to produce. To a large degree, gas monetisation is being driven by economic development needs among both producing and consuming countries and by initiatives such as Global Gas Flaring Reduction⁹, especially in areas where natural gas is associated with crude oil production. It is estimated that there is between 1,000 and 1,500 trillion cubic feet (Tcf) of stranded gas resources worldwide. In some case, gas is stranded because of physical distances and technical complexities associated with transportation. In many instances, however, gas is stranded because of a lack of sufficient demand in locations where the gas is produced. This condition is prevalent among developing and emerging market countries that are gas rich. Three main strategies are evident.

- Build transportation infrastructure density for domestic markets or regional export opportunities (midstream). This first strategy rests on the abilities of host governments to facilitate investment in pipeline networks. It means having commercial frameworks in place that not only attract investors but also protect affected public interests. For regional natural gas trade to occur, contiguous countries must have commercial frameworks that are similar enough to encourage market participants to develop cross-border networks, deal with risks, and efficiently allocate gains from trade.
- Convert gas to power, mainly for domestic use but in some cases for export. The global push to utilise relatively clean burning natural gas for power generation for both environmental benefits and power generation diversification has triggered strong convergence between the natural gas and electric power value chains. Importantly, how commercial frameworks for electric power are structured can have profound implications for natural gas value chain development.
- Export gas into the global marketplace through liquefied natural gas (LNG), gas-to-liquids (GTL) or other strategies. These strategies often link natural gas and crude oil for pricing and contractual arrangements.

A substantial level of investment is required worldwide to promote the use of natural gas. According to the International Energy Agency (IEA) World Energy Investment Outlook (2003), nearly one fifth of \$16 trillion of energy investment needed between 2001 and 2030 will be for the natural gas sector (see the IEA chart in Figure 8). Including electricity generation, most of which is expected to be from

⁸This section and the next are based on information from various presentations and publications of the Center for Energy Economics (CEE) but primarily from the Natural Gas Value Chain Overview chapter in the Economics of the Energy Industries workbook used in the CEE’s annual capacity building programme, *New Era in Oil, Gas & Power Value Creation* (www.beg.utexas.edu/energyecon). Other CEE publications include “Energy Policy in the Natural Gas Industry,” *Encyclopedia of Energy*, pp 219-233, Elsevier Science (New York), 2004 and “Global Natural Gas Issues and Challenges: A Commentary,” *Energy Journal*, Vol. 26, January 2005 both by Dr. Michelle Michot Foss.

⁹ See http://www2.ifc.org/ogmc/global_gas.htm.

natural gas-fired plants, investment needs associated with natural gas become doubly significant. A number of issues will impact any investment outlook for natural gas and the convergence of natural gas with electric power. One is the reduction in capital spending for exploration and development (E&D) as the international oil industry continues to consolidate, large producing basins mature and governments constrain sovereign commitments to national oil companies. As more E&D activity is subjected to global capital markets, investment will closely follow upstream returns.

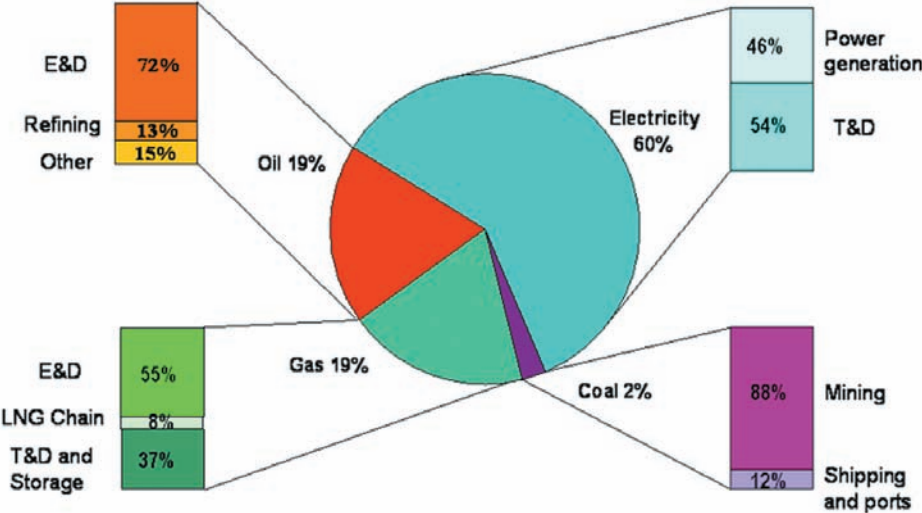


Figure 8 - IEA Chart on World Energy Investment

A second, more recent, phenomenon is the reduction in global capital flows as a result of the collapse of the US energy merchant businesses, most of which were financing new pipelines and power generation in many global locations with specific natural gas monetisation strategies. In developed markets like the US and Canada, the collapse of the energy merchants has also reduced liquidity in the natural gas marketplace (i.e., reduced the number of market participants), complicating risk management practices. Sovereign debt for infrastructure investment has been dramatically reduced over the years, a result of market and fiscal reforms (increasing the need for, and pressure on, private capital flows). Development assistance for infrastructure investment is also under pressure, as donor countries scrutinise more actively the results achieved thus far. All of these factors, and others, imply a more complicated picture for countries looking to provide incentives for private, foreign direct investment in their energy sectors.

2.7 Value chain overview

Figure 9 depicts the natural gas value chain, from exploration and production of natural gas to its transportation and delivery to consumers, either through local distribution companies or directly in the case of large users such as electric power plants or industrial customers. In a parallel fashion, the LNG and NGL value chains are also represented. We discussed different segments of the natural gas value chain above. In this section, we would like to consider policy and regulatory considerations associated with investing across this value chain.

The various segments of the value chain are highly interdependent. The policy challenges associated with increased worldwide use are numerous. Frameworks for efficient discovery and optimal production are the first hurdle. Efficient and equitable mechanisms, often at odds, for pipeline transportation and local distribution are the second major hurdle. Methane is of little use in consumer energy markets without pipeline infrastructure. These large systems tend to be characterised by strong technical economies of scale and high barriers to entry. Particular problems also emerge with respect to the public interest/public service component of these facilities. Reliability and pricing on systems that are usually operated in monopoly, duopoly or limited competitor regimes is of great concern. Achieving prices for natural gas transportation and distribution through tariff designs that yield something close to what competitive markets might be able to achieve is usually a goal for regulators.

A third challenge is the development of transparent markets for natural gas supply and consumption. Increasingly, the trend has been to separate infrastructure and product (often termed “unbundling”) and to search for ways of providing competitive access to pipeline systems for multiple suppliers and users of natural gas (often termed “third party access” or “open access”). In these cases, pipelines become like toll roads, priced through tariff design as noted above, while molecules become priced in discrete competitive markets. Once subjected to competitive markets, methane molecules become commoditised (see section 2.8 on Market Overview and Box 3 on Financial Markets for details on natural gas as a commodity).

Natural gas has been growing in importance in the international economy, as it becomes globalised via LNG shipments and linking disparate national and regional markets. The principal segments of a natural gas infrastructure system – exploration, production, transportation and distribution – share substantial capital requirements and comparable, albeit different, risks. The long lead times required for development of each sector’s assets present both industry and policymakers with the problem of adequately anticipating changes in supply and demand.

Both the evolution of market-based policies for natural gas and international trade linkages mean timely and accurate data and information on supply, demand and prices, a fourth requirement. A fifth and increasingly complicated challenge is dealing with integration, with respect to industry organisation and international trade. Industry organisation can encompass both vertical (meaning up and down the value chain) and horizontal (meaning over some geographic or market extent) integration. Paradoxically, the forces for integration within a natural gas industry often occur in spite of policy objectives that seek to encourage de-integration and competition as part of the transition to competitive markets. Integration of physical infrastructure across international boundaries such as the WAGP has grown rapidly with increased demand for piped methane.

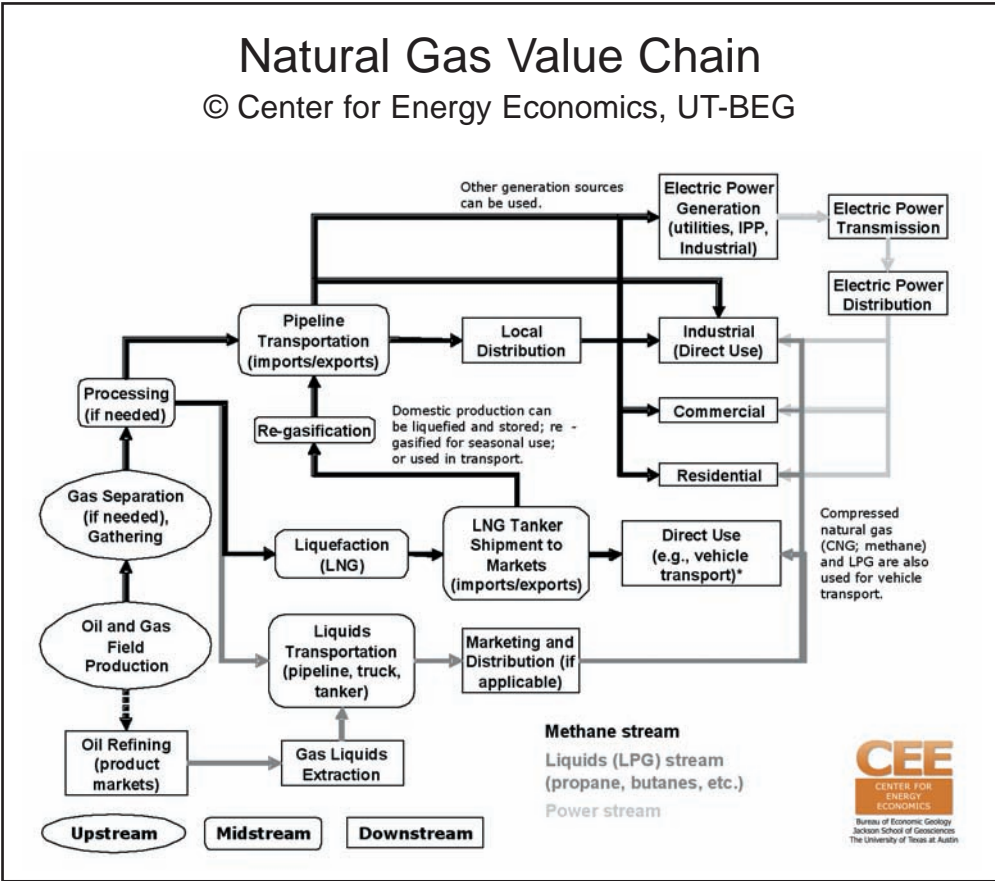


Figure 9 - Natural gas value chain

2.8 Market overview

Natural gas is traded between suppliers and consumers via physical long-term contracts. Suppliers can be producers themselves or marketers of natural gas, which could be affiliated with the producers; they could also be pipeline companies. There exist numerous types of physical trading contracts, but most share some standard specifications including specifying the buyer and seller, the price, the amount of natural gas to be sold, the receipt and delivery point, the tenure of the contract, and other terms and conditions. The special terms and conditions usually outline such things as the payment dates, quality specifications for the natural gas to be sold and any other specifications agreed on by both parties.

In a large and liquid market such as the one in the US, physical contracts are usually negotiated directly between buyers and sellers, but electronic bulletin boards and e-commerce trading sites are allowing more physical transactions to take place over the internet. The amount of natural gas is usually expressed in volume per day and contracts are expressed in number of days.

There are three main types of physical trading contracts: swing contracts, baseload contracts and firm contracts. Swing (or 'interruptible') contracts are usually short-term contracts and can be as short as one day and are usually not longer than a month. Under this type of contract, both the buyer and seller agree that delivery of the natural gas can be interrupted on short notice. These contracts are the most flexible, and are usually put in place when either the supply of gas from the seller, or the demand for gas from the buyer, are unreliable.

Baseload contracts are similar to swing contracts. Neither the buyer nor seller is obligated to deliver or receive the exact volume specified. However, it is agreed that both parties will attempt to deliver or receive the specified volume, on a 'best-efforts' basis. In addition, both parties generally agree not to end the agreement due to market price movements. Both of these understandings are not legal obligations - there is no legal recourse for either party if they believe the other party did not make its best effort to fulfill the agreement - they rely instead on the relationship (both personal and professional) between the buyer and seller.

Firm contracts are different from swing and baseload contracts in that there is legal recourse available to either party, should the other party fail to meet its obligations under the agreement. This means that both parties are legally obligated to either receive or deliver the amount of gas specified in the contract. These contracts are used primarily when both the supply and demand for the specified amount of natural gas are unlikely to change or drop off.

Box 3

Financial Market

There is also a significant market for natural gas derivatives and financial instruments in the US, Canada and the UK. In fact, it has been estimated that the value of trading that occurs on the financial market is twice the value of physical natural gas trading in the US. Derivatives are financial instruments that 'derive' their value from an underlying fundamental (the price of natural gas), and can be quite simple or very complex. Traditionally, most derivatives are traded on the over-the-counter (OTC) market, which is essentially a group of market players interested in exchanging certain derivatives among themselves, as opposed to through an organised exchange such as the New York Mercantile Exchange (NYMEX). Basic types of derivatives include futures, options and financial swaps. There are two possible objectives to trading in financial natural gas markets: hedging and speculation. Price volatility in the natural gas markets can result in financial risk for marketers and other market players as the price changes over time. Trading financial derivatives can help to mitigate, or 'hedge' this risk. A hedging strategy is created to reduce the risk of losing money. Purchasing homeowner's insurance is a common hedging activity. Similarly, a marketer who plans on selling natural gas in the spot market for the next month may be worried about rising or falling prices, and can use a variety of financial instruments to hedge against the possibility of natural gas being worth more or less in the future. Financial natural gas markets may also be used by market participants who wish to speculate about price movements or related events that may come about in the future. The main difference between speculation and hedging is that the objective of hedging is to reduce risk, whereas the objective of speculation is to take on risk in the hope of earning a financial return. Trading in the financial markets for speculative purposes is essentially making an investment in financial markets tied to natural gas, and financial speculators need not have any vested interest in the buying or selling of natural gas itself, only in the inherent underlying value that is represented in financial derivatives. While great profits may be made if the expectations of a speculator prove correct, great losses may also be incurred if these expectations are wrong. While the instruments used for hedging and speculation are the same, the way in which they are used determines whether or not they in fact, reduce or increase the risk of losing money.

In the international trade of natural gas, contracts are usually for longer terms (usually upwards of 10 years). Also, there are take-or-pay clauses, with the reciprocal clause of deliver-or-pay being very common. Producers require take-or-pay because in newly developing markets, they want to be paid regularly in order to cover their costs whether the consumers are able to take delivery of the gas or not. Similarly, consumers may want to get paid when the producer is not able to supply the contracted amount of gas so that they can make alternative fuel arrangements. In the case of WAGP, for example, the Volta River Authority (VRA) signed a long-term contract with the West African Pipeline Company (WAPCO) that guarantees a certain amount of natural gas consumption or equivalent monetary compensation, that is, a take-or-pay condition. This was done to ensure that pipeline investors will be able to recover their costs. For details on WAGP, please refer to Part II.

2.9 Regulating natural gas industry in developed and developing countries

This section discusses four country case studies – these are for two developed countries, the United States and the United Kingdom and for two emerging economies, Argentina and Mexico. The case studies provide several analogies and lessons for natural gas in Ghana.

United States

The US has the largest natural gas market in the world. It has been expanding for almost 100 years. As a result, the US has the longest and widest ranging transportation pipeline network in the world. It also has the largest number of cities with extensive distribution pipeline networks. There are many producers of natural gas in the US, including very small operations of several wells by individual-owned companies to largest operations by multinational companies such as Shell, ChevronTexaco, BP and ExxonMobil. There are also a very large number of natural gas consumers ranging from large industrial users such as petrochemical and fertiliser plants and aluminium smelters to commercial users of a variety of sizes, such as shopping malls, restaurants and the like. Heating consumption by households is also very significant, especially in the northern half of the country, where winters are cold. As such, it is very informative to study the US experience with natural gas.¹⁰

Natural gas exploration and production on private lands are regulated by state regulatory commissions, but this regulation is very light-handed and usually restricted to environmental and safety considerations. There are no regulations on production levels or prices. Companies are free to look for and evaluate natural gas fields and negotiate with private landowners if they want to pursue a prospect further. Exploration and production on public lands, onshore or offshore, are managed by federal or state agencies. Natural gas exploration and production, gathering and processing are all viewed to be “workably competitive” industries and are not regulated for prices. Tariffs for transportation within state boundaries on intrastate pipelines are regulated by state regulators (usually known as Public Utility Commissions or PUCs), which also license new intrastate pipelines. Tariffs for transportation across state boundaries in interstate pipelines are regulated by the Federal Energy Regulatory Commission (FERC). The FERC also issues licenses (certificates of public need) for new interstate pipelines. Tariffs for natural gas

¹⁰ To learn more about the U.S. natural gas industry and its history, please visit www.naturalgas.org

distribution to final customers are regulated by the PUCs. The most competitive gas service in the US is for industrial and electric power generation customers. The least competitive service is to residential customers.

The FERC is governed by five appointed commissioners and operates as an independent authority. Enabling legislation for the FERC dates back to the 1930s (it was created as the Federal Power Commission and charged principally with development of water and hydroelectric facilities). The FERC's authority to regulate interstate natural gas commerce is embodied in the 1938 Natural Gas Act. The individual state PUCs were established at various times, generally between the late-1800s through the 1970s. Each state has a separate enabling legislation for the formation of its PUC. Notable exceptions are the state of Nebraska, which does not regulate natural gas, and Texas, where natural gas is regulated by the Texas Railroad Commission rather than the PUC. The PUCs also vary with regard to numbers of commissioners, whether commissioners are elected or appointed and sizes of staffs and budgets. The FERC and state PUCs are funded through fees charged to regulated industries.¹¹

The style of regulation in the US traditionally has been "cost of service" or "rate of return," which involves a determination of revenue requirements and rate structures based upon costs provided by the regulated firms. A regulated company may be a local distribution company (LDC, or gas utility), an intrastate pipeline or an interstate pipeline. The regulated company's revenue requirements are the total funds that the company may collect from ratepayers (customers). Revenue requirements are calculated by multiplying the company's rate base by an allowed rate of return (ROR) and adding this product to the company's operating costs (OC), as shown in the formula below.

$$\text{Revenue requirement} = (\text{Rate base} \times \text{ROR}) + \text{OC} - (\text{Taxes} + \text{Depreciation})$$

The rate base is the total value of the company's capital investments, which may include construction work in progress. The allowed rate of return constitutes a profit sufficient to pay interest on accumulated debt and to provide a "fair" return to investors. A fair return is determined through a comparable earnings test (where a company's earnings are measured against those of a firm facing comparable risks), a discounted cash flow approach (where a company's capital costs are estimated by analysing conditions in the financial market), or some other method. Operating costs include expenses for purchased gas, labour, management, maintenance and advertising. The costs of taxes and depreciation are also part of a company's revenue requirements. The regulatory process can be generally described as follows:

- A regulatory commission (a PUC or the FERC) first seeks to determine how much of an applicant's capital stock should be included in the rate base, then attempts to determine which elements of test year costs and revenues should be allowed for regulatory purposes and whether or not to allow specific changes since the test year. The final step is to determine what the fair rate of return is for the company.

¹¹ Please visit www.ferc.gov and www.naruc.org to learn more about the federal and state regulatory agencies in the U.S.

- While states and the FERC have legal rules for deciding what should be included in the rate base, the same is not necessarily true for the method of calculating allowed rate of return.
- States may vary from each other and from the FERC according to the particular set of rules that are used, for example to calculate rate base, and the impact of these rules on rate case decisions. However, over the course of the long history of natural gas regulation in the US, the states and FERC have generally shared practices fairly quickly.
- All regulators are constrained in their abilities to calculate the cost of capital. This is due in part to general disagreement within the industry of how market cost of capital should be computed, and in part because commissions are not well equipped to deal with the complexities surrounding these issues. As a result, a critical component of a rate case proceeding is a commission's reliance on historical information, or precedent, as well as the testimony of interveners, parties with specific interests in the outcome of rate cases (principally large customers and consumer advocates representing small business and residential users; competing regulated firms may also intervene).

All US regulatory commissions hear rate cases, issue blanket rulings that set broad policy parameters and act as judges and adjudicators on disputes. In 1978, the US started to restructure its natural gas industry by deregulating production price controls, separating transportation of natural gas from its trade and opening up pipelines to common use. With the implementation of unbundling (separation of pipeline transportation from natural gas sales, with non-discriminatory "open access" or "third party access") in 1992, the FERC and many of the states now encouraged market-based rates for transportation service. With respect to distribution, many states are experimenting with "incentive-based" regulation designed to encourage more efficient operation and capital cost decisions than has historically been achieved with cost of service regulation. Only one state (Georgia) has experimented with unbundling for retail customers of LDCs.

Issues

Several issues remain following restructuring to restore and enhance competition in the US gas system. These include the following:

- Market disruptions. The FERC's actions to implement open access on US interstate pipelines created a "wholesale market" for bulk sales of natural gas, with competitive pricing, trading and marketing activities, price risk management (the New York Mercantile Exchange established a natural gas futures contract in 1993), market mechanisms to facilitate trading of unused pipeline capacity and a national standards board (North American Energy Standards Board or NAESB) to facilitate commercial activity. Beginning in 2000, surging prices for natural gas and electric generation constraints as a result of extended drought in the Pacific Northwest resulted in collapse of the electric power market in California. Disparities in natural gas prices between the California internal market and other US locations and related improprieties in natural gas trading, along with the bankruptcy of Enron Corporation, led to

a general collapse in the “energy merchant” segment including credit downgrades, additional bankruptcies and severe losses in market capitalisation. Energy merchant businesses deal in unregulated wholesale market activities, including construction and operation of competitive, unregulated infrastructure assets. Many energy merchants were affiliated with regulated natural gas interstate pipelines and utilities. Continued conflict around issues that emerged during these events heavily impacted natural gas markets in the US and Canada. A subsequent natural gas spike in 2003, with ancillary concerns regarding natural gas field production trends, and disputes regarding how natural gas price information is compiled and communicated in the marketplace continue to retard further policy, regulatory and commercial activity.

- Lack of competitive service to small retail residential and commercial customers at the end of distribution systems. Unbundling and open access to facilitate deliveries of competitive supply for smaller customers has not materialised as expected following FERC’s restructuring rule. These initiatives generally are in the domain of state jurisdictions, but federal/state coordination, always an issue, is required in some instances.
- Uncertainty with regard to electric power restructuring. Following early success with natural gas, some states (notably California in 1994) and the FERC (through Orders 888 and 889), and with encouragement through the Energy Policy Act of 1992, proceeded to experiment with similar unbundling and open access approaches for electricity grids. The 1992 Energy Policy Act supported creation of a bulk, wholesale market for electric power. The collapse of California’s electric power market and natural gas market disruptions have stymied further initiatives by the FERC for a segment of the energy sector that is considered to be crucial to the growth of the natural gas industry.
- Importing liquefied natural gas (LNG). As demand for natural gas has continued to grow and domestic production has failed to keep up, the US has been considering importing more natural gas in the form of LNG from North and West Africa, Australia, the Middle East and the Caribbean. FERC is one of the lead agencies, responsible for licensing terminals to receive LNG. With the notable exception of the Gulf Coast, there has been significant local opposition to these facilities. As a result, there have been conflicts between local officials and regulators and FERC. While Congress debated a way to give FERC more authority to manage these issues, several plants were approved. Nevertheless, the future of gas supplies in the U.S. may depend on the ability to build import terminals where the gas is needed, such as in the northeast.

Britain

Like the US and Canada, Britain’s national gas grid evolved to transport “town gas” manufactured from coal by state-owned British Gas. However, unlike its North American counterparts, Britain’s grid was not converted to natural gas until the 1960s. As the first gas came ashore from West Solefield in the North Sea in 1967, British Gas began the process of transforming its business. By comparison, discovery of natural gas in the US at the turn of the 20th Century, first in the

Appalachians and later in the Southwest (Texas and Oklahoma), had already launched the U.S. natural gas industry. Britain has moved much more quickly than the US to allow competition for retail residential and small commercial customers. Restructuring of the British natural gas sector involved a series of steps as outlined below:

- Passage of the Oil and Gas (Enterprises) Act of 1982, which laid out the process for privatisation. The main issue was to break down the monopoly British Gas had of the gas supply market thus enabling the introduction of competition in gas supply.
- Privatisation of British Gas (BG) with the Gas Act of 1986 and creation of The Office of Gas (Ofgas) as regulator to monitor the privatization of the gas industry and ensure customers' rights are recognized in every aspect.¹²
- Initiation of competition in the contract market (large industrial and electric utility users who use more than 2,500 therms per year) in 1989. This entailed cancellation of existing take-or-pay contracts with suppliers (a process nearly as contentious as that required in the US for interstate pipeline unbundling).
- Accelerated competition in the contract market with government targets and issuance of licenses to qualified customers taking more than 2,500 therms per year at a single site in 1992.
- Creation of the gas cost index in 1992 to limit cost pass-throughs by BG to domestic customers who use 2,500 therms per year or less.
- Passage of the Competition and Service (Utilities) Act in 1992 which included natural gas service standards.
- Passage of the Gas Act of 1995 which laid out targets for full competition in the domestic sector by 1998.
- Creation of the Network Code in 1996 to ensure smooth operation of the liberalised UK gas industry.

The mechanism for competition within the gas market had been implemented with the creation of major new private sector companies. Some were established by oil companies active in the North Sea; others were ventures by the electricity companies and some were truly independent. The Gas Act emphasised the need for vigorous competition among the new Independent Suppliers with the objective of undercutting British Gas prices. The goal was to introduce competition in stages with the industrial sector first, followed by commercial and then residential users.

Issues

The primary issues associated with Britain's gas restructuring were the following:

- Take-or-pay (Top) contract resolution. BG held contracts with North Sea gas producers for supply. With falling gas prices as a consequence of competition,

¹² Ofgas was later merged with the Office of Electricity (Offer) to form a regulator that is responsible for both natural gas and electricity, the Office of Gas and Electricity Markets (Ofgem). Please visit www.ofgem.com for detailed information on Ofgem's activities and the British natural gas market.

BG and its suppliers faced a situation in which the value of gas in the contract was higher than in the marketplace, rendering the contract unsustainable, while new competitors in the UK market were able to contract for the cheapest gas supplies. Renegotiation of the ToP contracts was essential to implementation of restructuring, but the issues over reapportioning costs became politically difficult.

- Low margins to gas suppliers. With the onset of competition and falling gas prices, suppliers in the UK face low and diminishing profit margins in their businesses.
- Slow implementation of domestic competition. As in the US and Canada, fear and uncertainty about the reliability of gas service and ultimate cost of service, particularly to residential customers, have delayed full implementation of domestic competition.
- Coordination with other European initiatives. Britain leads Europe in creating a competitive natural gas market. In 1997, the European Union Council established a directive allowing large customers (above 25,000 cubic metres) to select from competitive suppliers with a target of the year 2000 for implementation by member states. Initially, each member state was to grant third party access (TPA) to 20 % of the market (reducing the customer threshold if necessary), with TPA reaching 28 % after five years and 33 % in 10 years. States have moved very slowly with this directive, with few countries establishing independent regulators or forcing incumbent monopolies to respond in spite of court actions.

Argentina

Until its recent financial and economic travails, Argentina had made great strides in building a competitive market for natural gas. Most of these initiatives survived the economic depression in 2000, but natural gas market participants suffered along with the rest of the economy during this period. In particular, policies by the national government to provide “political” relief following financial collapse included caps on natural gas prices. These caps discouraged producers. Insufficient supplies of natural gas triggered abrogation of supply contracts to major customers in Chile. As a result, the entire “Southern Cone” regional natural gas market was damaged. In the late 1980s, the government of Argentina began to privatise state-owned energy companies as part of an economic reform drive to combat hyperinflation and a chronically underperforming domestic economy. These efforts included the privatisations of Gas del Estado, which controlled the Argentine natural gas transportation and distribution grids, and Yacimientos Petroliferos Fiscales-Argentina (YPF-A), the national oil and gas company, which was later acquired by Repsol from Spain. Argentina now has two main transportation companies, Transportadora del Gas Norte (TGN) and Transportadora del Gas Sur (TGS), both owned and operated by consortia of Argentine, US, Canadian and European companies. Eight investor-owned distribution systems are now in operation, also with combinations of Argentine and foreign direct investment. The transportation system and portions of the distribution systems operate under open access conditions following the Canadian and US systems. As in Canada and the US, physical, economic bypass is allowed.

The regulatory framework in Argentina is provided by Ente Nacional Regulador del Gas (ENARGAS), an independent national commission. ENARGAS maintains several objectives, which include:

- Protecting consumers' rights
- Promoting competition
- Guaranteeing long term investment
- Regulating distribution and transport services
- Guaranteeing fair and non discriminatory tariffs.

For tariff regulation, ENARGAS uses a variation of the British RPI-X methodology and incentive mechanisms to reward performance by private operators. Prices to final customers are unbundled and the pass through method is used to guarantee price transparency. The formula is specified as follows:

Total price = Gas price + Transportation price + Distribution margin

Subsidised tariffs are allowed for certain customers but must be justified to the Presupuesto Nacional, the federal budget authority. No dumping of gas is permitted. Tariffs vary with distance and type of contract (firm or interruptible) as in the US, Canada and Britain. It is possible to adjust distribution tariffs as often as every six months in correlation with the US price index and productivity factors. Because the Argentine dollar was pegged to the US dollar as an anti-inflation strategy, US price movements are used in a variety of Argentine economic sectors. It is also possible to adjust distribution tariffs seasonally. The overall tariff structure is revised every 15 years. ENARGAS has several roles and principle functions. Accordingly, ENARGAS :

- Advises users
- Publishes information on the industry's evolution and maintains a comprehensive library
- Approves transportation and distribution tariffs
- Authorises the building and expansion of transportation and distribution networks
- Fosters open access and non discriminatory treatment
- Normalises gas quality, measurement and odorisation processes, and security
- Establishes the rules for new pipeline and LDC permits
- Implement sanctions
- Performs regular inspections of sites
- Is required to disseminate periodic information to the companies that participate in the industry
- Guarantees competitive business practices
- Acts as a judge
- Resolves controversies between companies and third interested parties through public consultations.

ENARGAS has three appointed commissioners. The commission uses both internal and external auditors to monitor its activities and reports to the national executive branch of the Argentine government. The commission resolves disputes using public consultations and general resolutions. This counters the style of US and

Canadian commissions which use open hearings and technical conferences to allow input into decision making and for dispute settlement. ENARGAS is an independent regulatory commission, with no influence from Argentina's energy ministry.

The potential still exists in Argentina for a healthy gas (and power) commodity market with trading and marketing activities used by producers, marketers and large customers (including local distributors) to hedge against natural gas price volatility. Repsol-YPF retains a dominant position in the upstream sector, accounting for 33% of the country's natural gas production, followed by Total Austral SA with 19%.

Mexico

Mexico has pursued a strategy of reserving upstream petroleum and gas exploration to Petroleos Mexicanos (Pemex), the national oil company. During the early days of Mexico's industry, oil and gas exploration were carried out by private foreign and Mexican companies. Disputes between the Mexican government and foreign operators, and political imperatives following Mexico's revolution, resulted in the 1938 nationalisation of Mexico's oil industry. Article 27 of the regulatory law to Mexico's constitution stipulates that Pemex has sole control of the production of oil and gas and the products derived from the raw resources.

During the 1970s, hydrocarbon production did not keep pace with economic modernisation, so that by 1973 Mexico found itself to be a net importer of crude oil. Critical discoveries restored Mexico's stature as an oil producer and exporter. Investment in upstream activities continued until the early 1980s when Mexico's external debt crisis, exacerbated by falling world crude prices, triggered a contraction in government spending. The collapse of crude prices in 1986 impacted upstream activity even more. Spending by Pemex on exploration and production dropped from its peak of approximately 86 % of Pemex's total budget in 1982 to less than 60 % in 1988. Historically, crude oil has been given priority because of its export potential and value.

However, two factors contributed to an effort to increase natural gas production. One, in the late 1970s, was the desire to increase gas sales to the US which led to construction of the Cactus-Reynosa pipeline as a result of negotiations between Pemex and Border Gas, a consortium of US companies. The 2 Bcf/day project was never realised because of disputes about pricing. The second factor was concern about inefficient utilisation of energy. Expenditures were made to gather and transmit gas, especially from the huge Bay of Campeche fields, and reduce wasteful gas flaring, which declined from 26% of production in 1970 to less than 3% by 1989. Domestic consumption of natural gas continued to grow in the 1980s, but with relatively little new investment in natural gas production and transmission made by Pemex. The result is Mexico's current situation of inadequate domestic production capacity to satisfy natural gas demand.

In the 1990s, in response to the critical economic situation Mexico faced after the oil market crash and currency devaluations, the Mexican government began to implement market reforms. Public opinion and political will for privatising Pemex

have historically been weak, but a series of major accidents, chronic shortages and unreliable service forced the managers at Pemex to take action. The government gradually removed the obligations on Pemex to provide everything from roads to hospitals and schools as part of its social obligations to the state. Pemex began to reduce its huge employment from more than 250,000 to just over 133,000 today. In 1992, Pemex was reorganised into four functional subsidiaries for exploration and production, refining, natural gas and basic petrochemicals and secondary petrochemicals. The government also changed Pemex's tax status by creating a corporate tax rather than controlling all of Pemex's revenues and returning some portion to the company for reinvestment. The corporate tax rate for Pemex remains high (more than 60%) and Pemex still does not have independence with respect to its budget planning.

In 1995, further, more dramatic steps were taken to reform Mexico's energy sector. The regulatory law to the constitution was changed to allow private investment in natural gas transportation, distribution and storage, in recognition of the importance of this fuel to Mexico's economic development. A regulatory commission has been created (the Comisión Reguladora de Energía or CRE), charged with the privatisation of assets formerly controlled by Pemex. Rules have been established for pipeline tariffs and first hand sales of imported gas from the US (although Pemex is expected, at some point, to resume its bid to be a net exporter of gas). The CRE handled all auctions for state-owned assets (portions of the Pemex pipeline grid and local distribution networks) that were turned over to private operators, and uses a price cap formula similar to the Ofgas RPI-X to regulate tariffs.

In spite of all of these reforms, deep problems persist in Mexico's oil and gas sector. Pemex has watched its market share of exported oil erode as other countries have moved aggressively to lure private investment into their upstream business. The investment demands on Pemex for improvement and expansion projects are huge. While the company has had some success with foreign placements of debt, many questions remain about Pemex's ability to finance capital improvements. In order to ensure adequate supplies and diverse supplies of natural gas, Mexico has pursued new LNG import terminal developments. The CRE issued permits to two new facilities, with Comisión Federal de Electricidad (CFE) tendering the long term offtake contracts. Additional LNG import terminals are expected to be built. The CRE has five appointed commissioners. A law passed by the Mexican Congress in 1995 established the CRE as an independent entity, but Mexico's energy ministry retains a great deal of influence. Like ENARGAS, the CRE handles conflicts and disputes with operators through private consultations rather than the public meetings typical of the US and Canada.

2.10 Future prospects of the natural gas industry

There are significant reserves of natural gas around the world, waiting to be developed. Although the former Soviet republics (in particular Russia) and the Middle East own most of the known reserves in the world, there are large reserves in West Africa, Latin America, North America and Southeast Asia (including Australia and other Pacific Island nations). Through regional pipeline developments such as the WAGP and increased LNG trade, these reserves can be made available to a larger group of countries around the world. Natural gas

replacing other fuels will help countries reduce or prevent air pollution, generate electricity more efficiently, diversify their fuel portfolios and help expand a variety of industries. As such, natural gas offers a large potential for improving standards of living.

In order to extend the benefits of natural gas events further, intensified research, development and demonstration (RD&D) programmes focusing on end-use and supply technologies need to be expanded. Research opportunities for natural gas include:

Combustion Systems

Natural gas combustion systems have the potential to be inherently efficient since the energy is delivered directly to the point of use with little loss in energy conversion or transportation. The primary object of this area of research is to support environmental and economic goals with the development of a family of advanced gas technologies aimed at maximising fuel efficiency while demonstrating the cleanest combustion attainable from stationary sources. Industrial boilers, furnaces and dryers, municipal solid waste systems and other stationary sources can be major polluters. Research programmes are needed on the use of natural gas for emissions control, as in co-firing, reburn and other gas treatment procedures, and on advanced combustion systems with fibre and catalytic burners. Programmes should also focus on energy conversion efficiency, such as advanced heat engines, and should be supported by basic research in combustion chemistry, engineering concepts, and advanced materials, components and processes.

Natural Gas Cooling

Government involvement in natural gas cooling RD&D needs to be increased. The development of non-chlorofluorocarbon (CFC) gas absorption and desiccant equipment is especially important during the phase-out of CFC-based refrigerants in the heating, ventilating and air conditioning industry. This industry faced a fundamental shift in that cooling equipment manufactured in the year 2005 was substantially different from that sold in 1990. Gas cooling provides a viable, environmentally friendly option when manufacturers and consumers are looking for an alternative choice.

Natural Gas Vehicles

Alternative-fuel vehicles, particularly in fleet applications, could be an important part of the solution to environmental and energy security problems. Natural gas vehicles (NGVs) are proven to have economic, operating and environmental advantages over gasoline vehicles. For example, compressed natural gas (CNG) is used in taxi and bus fleets in a variety of cities around the world, such as New Delhi and Dhaka, as well as airport bus fleets in many cities around the US and Europe. LNG is effective for heavy trucks and fleets but focused research is needed to ensure development of new vehicle designs, optimal engine performance and natural gas storage, distribution and fueling technologies.

An indirect way to use natural gas in the transportation sector is to transform it into diesel via gas-to-liquids (GTL) technology. This technology has been around for some time but was expensive. Recently, several major companies have announced large-scale GTL plants in Nigeria and Qatar, where low-cost natural gas is available. Given high oil prices, diesel from the GTL process will be reasonably priced. In addition, it will burn cleaner than oil products, emitting fewer pollutants. However, there is still room for improving the technology, especially when it comes to reducing byproducts such as wax.

Fuel Cells

Natural gas-powered fuel cells convert the energy content of gas directly into electricity and byproduct heat using a highly efficient electrochemical process. Fuel cells produce electricity with only a fraction of the air pollution and with considerably higher efficiency than combustion-based power plants. Technology transfer assistance is necessary for phosphoric acid fuel cell development, and accelerated research and development is needed on molten-carbonate and solid-electrolyte fuel cells.

Natural Gas Supply

Extraction and recovery techniques can be made even more efficient so that future demand for natural gas can be met at competitive prices and in a way that minimises the environmental impact of energy production. This research should be complemented by continuing efforts to develop methods for extracting higher quality methane gas from biomass, a potentially huge resource of low-cost renewable energy as well as from unconventional sources such as coal beds and gas shales.

PART II

3.0 NATURAL GAS IN GHANA

3.1 Introduction

The oil and gas industry comprises two parts: “upstream” – the exploration and production sector of the industry; and “downstream” – the sector which deals with refining and processing of crude oil and gas products, their distribution and marketing. Companies operating in the industry may be regarded as fully integrated, (ie having both upstream and downstream interests), or may concentrate on a particular sector, such as exploration and production, commonly known as an E&P company or just on refining and marketing (known as an R&M company). Many large companies operate globally and are described as “multinationals”, whilst other smaller companies concentrate on specific areas of the world and are referred to as “independents”. Frequently, a specific country has vested interests in oil and gas in a national company, with its name often reflecting its national parenthood.

In the upstream sector, much reliance is placed upon service and upon contractor companies who provide specialist technical services to the industry, ranging from geophysical surveys, drilling and cementing, to catering and hotel services in support of operations.

This relationship between contractor and oil companies has fostered a close partnership, and increasingly, contractors are fully integrated with the structure and culture of their client.

In the ensuing sections, we will seek to obtain an appreciation of the petroleum industry in terms of what is happening with Ghana’s exploration efforts and the West African Gas Pipeline Project.

3.2 Sources and consumption patterns of petroleum and natural gas in Ghana

The oil and gas industry is very important to the socio-economic development of the country. The industry provides energy for almost all the sectors of the economy. Consequently, the activities of this industry to a large extent determine the rate of economic growth and level of development of the country. The industry also provides revenue for government in the form of taxes and levies incorporated into the petroleum products price build-up.

It has been realised that the industry provides a substantial portion of commercial energy. In the year 2000, about 75% of the commercial energy consumed in the country was from petroleum products. The total amount of petroleum products consumed in the year 2000 was 1.5 million metric tons. This has been increasing at an average annual rate of about 8% over the past few years.

Despite exploration activities since 1896, which have resulted in the drilling of over 66 wells, no commercially sustainable deposits of oil and gas have been discovered. The country therefore imports 45,000 barrels per day of crude oil from Nigeria on a

government-to-government contract, which is just about 70% of petroleum needs. The balance is obtained in the form of petroleum product obtained from the international market by competitive bidding.

3.3 The effects of petroleum and natural gas importation on the economy of Ghana

It has been estimated that the country spends as much as 20-30% of its export earnings on crude oil and petroleum products importation depending on the world market prices of these products. An amount of US\$ 528 million, about 27% of the country's total export earnings were spent on the importation of about 1.1 million metric tons of crude oil and 0.8 million metric tons of petroleum products in the year. Consumption of products in 2002 was about 1.64 million metric tons. It was projected in 2002 that demand for petroleum products would increase by 28% from 2003 to 2008 from 1.9 million metric tons to 2.43 million metric tons. Product supply from the Tema Oil Refinery (TOR) during the same projected period would range from 1.4 million metric tons to 1.8 million metric tons. This gives a projected product shortfall per annum of between 0.2 million metric tons to 0.8 million metric tons.

3.4 Nature and origin of natural gas exploration in Ghana

Exploration for oil and gas in Ghana can be divided into three phases. The first phase was between the years 1896 and 1967 when exploration was concentrated in the offshore Tano, Keta and Voltaian basins (see figure 10). During this period, a total of 16 wells were drilled around known oil seepages, mostly without relying on any form of seismic data.

The second phase was between the years 1967 and 1981. During this period, 24 concessions offshore were licensed to private foreign companies for exploration. More than 31 wells were drilled during this period. These activities led to the discovery of three oil and gas accumulations, which are the oil and gas at the Saltpond Field in the year 1970, natural gas accumulation at Cape Three Points in the year 1974 and the oil and gas accumulation in the North and South Tano Fields in the years 1978 and 1981. The Saltpond Field was developed and put into operation with a production rate of about 4,800 barrels per day by Agri-Petco of the USA. This however declined to about 680 barrels per day by the mid 1980s when it was shutdown in 1985.

The third phase of the exploration activities has been between the years 1981 and 2006. This phase began with seismic data retrieval and gathering in the shallow water areas. In the year 1982, the government initiated a restructuring of the whole energy sector. A comprehensive plan to accelerate the pace of petroleum exploration and development was established with the enactment of three laws (see Appendices 2, 3 and 4 for details), namely:

- The Ghana National Petroleum Corporation Law (PNDC Law 64) in 1983
- The Petroleum Exploration and Production Law (PNDC Law 84) in 1984, and
- The Petroleum Income Tax Law (PNDC Law 188) in 1987.

It is important to note that until this phase, oil and gas exploration in Ghana was episodic, until the inception of the Ghana National Petroleum Corporation (GNPC) in 1983-84.

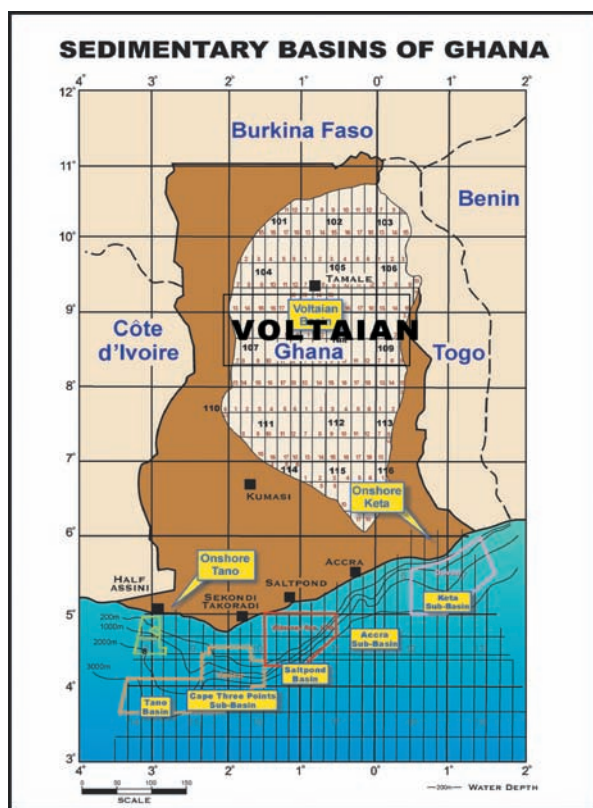


Figure 10

3.5 Potential benefits of petroleum and natural gas exploration for Ghanaian society and economy

Crude oil and petroleum product imports still constitute the single highest consumers of the country's foreign exchange. In the early 80s almost half of the nation's foreign exchange earnings went into petroleum imports. Currently over 20% of foreign exchange earnings are spent on importing petroleum. In recent times, even though Ghana's foreign exchange earnings have increased, there has been a concomitant increase in the world market price of crude oil.

The crude oil price increases of the 1970s and early 1980s had a major impact on Ghana's economy as

they did to other oil importing developing countries, particularly because at the time inappropriate pricing of foreign exchange under a fixed exchange rate regime led to massive subsidies on petroleum products.

While world oil prices by 1980 were more than five times 1972 levels, in real terms the prices of petroleum products in Ghana in 1980 were below their 1972 levels. Smuggling to neighbouring countries flourished under these circumstances. The petroleum sector thus contributed in no small measure to the distortions in the Ghanaian economy. These same phenomena can be observed in the country today as world market prices for crude began to increase in 2000 and remain stubbornly high by historic standards. The country now spends in excess of US\$ 1 billion per annum in the importation of petroleum products.

Local production therefore, of even a third of Ghana's crude oil requirements would easily save about US\$ 350 million annually, resources which could then be made available to other areas of the national economy.

The availability of natural gas could afford the country the following benefits amongst others:

- displace liquid fuels in power generation and industry in Ghana.
- contribute towards the reduction of emissions of greenhouse gases in the country.
- lead to value added processing of minerals.

3.6 History of natural gas prospecting in Ghana – achievements and failures

Surface seepages of oil have been known in Ghana for a long time. Not far from the border with La Côte d'Ivoire, onshore prospecting for hydrocarbons by the international industry began as far back as the last decade of the 19th century near some of these seepages. Many of these onshore wells drilled, then and over the following three decades, flowed small amounts of crude oil, and some production is reported during the Second World War.

It was also in this onshore area that in the 1950s four very deep wells were drilled along the coastline by Gulf Oil. In 1965, the Romanian government provided technical assistance to the Ghana Geological Survey Department in undertaking exploratory drilling on the coastal area to the Southwest; wells were drilled at Anloga and Atiavi. Hydro-geological investigations in the Voltaian basin in the 1960s also encountered bituminous material, but only one deep well was ever drilled in this huge basin by Shell in the southern part in 1978. From 1966 onwards exploratory work extended offshore, as concessions were granted to a number of international companies offshore, among them Amoco, Chevron, Mobil, Occidental, and Signal Union Carbide.

A consortium of US companies, with Mesa Petroleum as operator, also drilled a well at Dzita in the same onshore Keta Basin in the early 1970s. In 1970, the Saltpond field was discovered by the AMOCO/SIGNAL Consortium. This was a small field with less than 50 million barrels of light low sulphur crude oil in place. With low crude oil prices at the time, the consortium relinquished it as not commercial. In 1974 another consortium of companies (Phillips, Zapata, Oxoco, Agip), with Phillips Petroleum as operator, made the first discovery of natural gas in Ghana in the Cape Three Points sub-basin. That discovery was never appraised, as gas was not of interest to the companies due to a lack of local markets for natural gas.

Currently, exploration activities involve acquisition, processing and reprocessing and interpretation of seismic data. Up to 3,000m bathymeters (water depth) covering an area of 50,000 sq km and 29,000 sq km are either licensed or subject to negotiations. About 21,000 sq km are open and 3,000 sq km of coastal onshore sedimentary basins are available. The Voltaian Basin of 103,000 sq km has only one well drilled and 230 km 2-D seismic data despite its potential for oil generation and accumulation.

3.7 Key regulators, actors, functionaries of energy sector of Ghana

The following are the key institutions in the oil and gas sector and their functions:

Institution	Functions
Ministry of Energy	Formulation of policies
Energy Commission	Licensing of Energy Service providers, development of indicative national energy plans and advising the Minister on energy policy issues
Ghana National Petroleum Corporation	Oil and Gas exploration and production
Tema Oil Refinery	Importation of crude oil, petroleum products refining of crude oil and bulk sale of petroleum products
National Petroleum Authority	Regulates the downstream petroleum sector
Bulk Oil Storage and Transportation Company	Planning and management of strategic stocks of petroleum products
Environmental Protection Agency	Safeguarding the environment from the impact of activities in the energy and other sectors of the economy
Oil Marketing Companies	Distribution and marketing of petroleum products
Energy Foundation	Specialising in energy efficiency and renewable energy solutions to Ghanaian residential, industrial and commercial energy consumers
PURC	Regulating tariffs and performance of the electricity, water and gas sectors
Retail Outlets	Retailing sale of petroleum products to the public

3.8 The Establishment and functions of GNPC

The Ghana National Petroleum Corporation was established by PNDC Law 64 in 1983, but did not begin to operate until 1985. PNDC Law 64 states the functions of GNPC to be the exploration for development, production and disposal of petroleum.

GNPC'S tasks are further spelt out in PNDC Law 64 as follows:

- To promote the exploration of and the orderly and planned development of the petroleum resources of Ghana;
- To ensure that Ghana obtains the greatest possible benefits from the development of its petroleum resources;

- To obtain the effective transfer to Ghana of appropriate technology relating to petroleum operations;
- To ensure the training of citizens of Ghana and the development of national capabilities in all aspects of petroleum operations; and
- To ensure that petroleum operations are conducted in such a manner as to prevent adverse effects on the environment, resources and people of Ghana.

The establishment of the corporation signalled a more determined and systematic national outlook as far as the petroleum industry is concerned, especially with regard to exploration. Ghana's long recognised potential for oil and gas production needs to be realised soon so that the burden of crude oil imports is lifted.

3.9 Review of petroleum and oil exploration in Ghana

The offshore sedimentary basins up to 3,000m bathymeters cover an area of about 50,000 sq km. Also available are about 3,000 sq km of coastal onshore sedimentary basins. One of these is the Onshore Tano Basin where we have the oil seepages.

There is also the interior Voltaian Basin, which is about 103,000 sq km in area. This basin has seen very little exploration despite the fact that it has a good potential for oil generation and accumulation. For example, only one exploration well has been drilled and 230 kilometres of 2-D seismic data shot in this basin. Water wells drilled in parts of this basin have encountered dead oil stains.

There are currently three companies with substantive licences for exploration in Ghana and there is another company undertaking the redevelopment of the Saltpond fields. Some companies have submitted applications that are being reviewed and still others have expressed an interest in obtaining licences to operate in the open acreages.

The potential for commercial oil and gas discovery in the remaining open acreage is high. In all about 48 exploration wells have been drilled in Ghana's sedimentary basins, which is about 150,000 sq km. 75% of these wells have encountered oil or gas shows and seven of them have been discoveries. The Ghana National Petroleum Corporation (GNPC) with previous and present operators has identified over 70 undrilled prospects and leads with high potential for hydrocarbon accumulation.

From 1996 to date companies awarded blocks have in conjunction with GNPC, acquired, processed and interpreted over 3,500 sq km of 3-D seismic data out of which 2,400 sq km are in deepwater. 8,000 km of 2-D seismic data has also been acquired in addition to the reprocessing of over 21,000 km of 2D seismic data.

Given the prospectivity of our basins, there is the urgent need to at least maintain the momentum of the current exploration and promotion activities. The State Oil and Gas Company, GNPC with assistance and support from Government, is therefore currently engaged in activities aimed at:

1. Sustaining the current levels of exploration, by assisting the various operators in their farm-in drives;
2. Attracting new companies to the open acreage.

GNPC will continue to re-evaluate the existing data and integrate the results of drilling and other exploration activities as they become available, and also continue with its aggressive promotional campaign. Under exceptional circumstances, new data will be acquired either on speculative or under special delayed payment arrangements with service companies, especially in the deepwater and virgin areas like the Voltaian Basin. This will be done in close collaboration with industry in a manner that will not saddle the Corporation with long-term debts.

Since 1996/97 when these companies were awarded their blocks, they, in conjunction with GNPC, have acquired, processed and interpreted about 3,500 sq km of 3-D seismic data out of which 2,400 sq km are in deepwater. About 8,000 km of 2-D seismic data have also been acquired in addition to the reprocessing of another 21,000 km of 2-D seismic data.

For the GNPC to play its role effectively under the current Petroleum Agreements, GNPC Law, (PNDC Law 64) and Exploration and Production Law (PNDC Law 84), it is important that the Corporation is retooled with modern computers (workstations) in tune with current industry demands. Until recently, the Corporation was able to promote the country's petroleum potential with its pencil and paper maps. It is becoming increasingly difficult to continue with this antiquated medium because the multinationals cannot use our data and we cannot use theirs, because of the vast differences in media and formats.

3.10 State action and policy issues of petroleum and natural gas industry in Ghana

To achieve government's policy objectives in the petroleum upstream sector, the following are being pursued:

- Undertaking effective programmes for institution building;
- Accelerating petroleum exploration activities in association with international oil companies to achieve commercial production; and
- Appraising existing oil and gas discoveries with the view to developing and producing these where feasible and economically viable, having particular regard to national requirements.

A comprehensive plan to accelerate the pace of petroleum exploration and development was established with the enactment of three laws to govern petroleum upstream operations.

- The Ghana National Petroleum Corporation Law (PNDC Law 64) in 1983. This law established GNPC as the sole government agency to promote the exploration and orderly and planned development of petroleum resources in the country.
- The Petroleum Exploration and Production Law (PNDC Law 84) in 1984. This law sets out the legal and regulatory framework for petroleum exploration and production in Ghana. It also sets out the fiscal regimes under which such exploration and production is to be undertaken and describes the role of all institutional participants.

- The Petroleum Income Tax Law (PNDC Law 188) in 1987. This law spells out the tax policy of the government for companies engaged in petroleum operations.

A model agreement has been synthesized and formulated from the three laws as a basic negotiating document. The model agreement is based on the following:

- Acreage Exploration Period: first phase – 3 years, a second extension of 2 years and a third extension of 2 years
- Work programme
- Relinquishment clause
- Royalties of 10-25 % for oil and gas
- Corporate tax.

In addition to the above, GNPC has Carried Interest of 10% and also charges for surface rental, training allowance and capital allowance.

3.11 Petroleum and natural gas exploration environmental and safety issues

The major environmental issues associated with petroleum and natural gas exploration include the following:

- Atmospheric impacts
- Aquatic impacts
- Terrestrial impacts
- Ecosystem impacts.

The primary sources of atmospheric emissions from oil and gas operations arise from:

- Flaring, venting and purging gases
- Combustion processes such as diesel engines and gas turbines
- Fugitive gases from loading operations and tankage and losses from processing equipment
- Airborne particulates from soil disturbances during construction and from vehicular traffic, and
- Particulates from other burning sources, such as well testing.

The principal emission gases include carbon dioxide, carbon monoxide, methane, volatile organic compounds and nitrogen oxides. Emissions of sulphur dioxides and hydrogen sulphide can occur and depend upon the sulphur content of hydrocarbon and diesel fuel, particularly when used as a power source. In some cases sulphur content can lead to odour near the facility.

The principal aqueous waste streams resulting from exploration and production operations are:

- Produced water
- Drilling fluids, cuttings and well treatment chemicals

- Process, wash and drainage water
- Sewerage, sanitary and domestic waste
- Spills and leakage, and
- Cooling water.

The volumes of waste produced depend on the stage of the exploration and production process. During seismic operations, waste volumes are minimal and relate mainly to camp or vessel activities. In exploratory drilling the main aqueous effluents are drilling fluids and cuttings, whilst in production operations – after the development wells are completed – the primary effluent is produced.

Terrestrial impacts i.e. potential impacts on soil arise from three basic sources:

- Physical disturbance as a result of construction
- Contamination resulting from spillage and leakage or solid waste disposal, and
- Indirect impact arising from opening access and social change.

Potential impacts that may result from poor design and construction include soil erosion due to soil structure, slope or rainfall. Left undisturbed and vegetated soils will maintain their integrity, but once vegetation is removed and soil is exposed, soil erosion may result. Alterations to soil conditions may result in widespread secondary impacts such as changes in surface hydrology and drainage patterns, increased silt formation and habitat damage, reducing the capacity of the environment to support vegetation and wildlife.

Plant and animal communities may also be directly affected by changes in their environment through variations in water, air and soil/sediment quality and through disturbance by noise, extraneous light and changes in vegetation cover. These are known as ecosystem impacts. Such changes may directly affect the ecology: for example, habitat, food and nutrient supplies, breeding areas, migration routes, vulnerability to predators or changes in herbivore grazing patterns, which may then have a secondary effect on predators. Soil disturbance and removal of vegetation and secondary effects such as erosion and silt formation may have an impact on ecological integrity and may lead to indirect effects by upsetting nutrient balances and microbial activity in the soil. If not properly controlled, a potential long term effect is loss of habitat which affects both fauna and flora, and may induce changes in species composition and primary production cycles.

Finally, even with proper planning, design and the implementation of correct procedures and personnel training, incidents can occur such as:

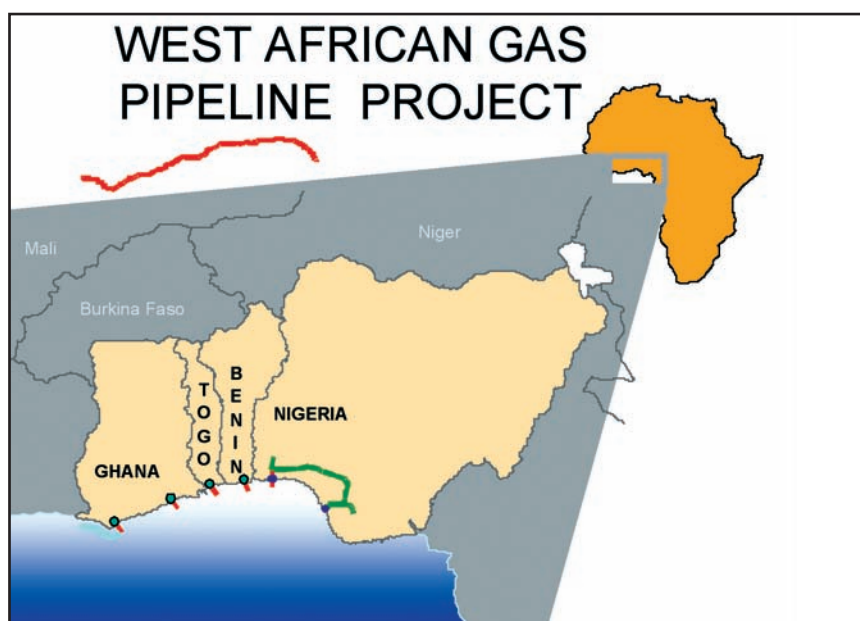
- Spillage of fuel, oil, gas, chemicals and hazardous materials
- Oil or gas well blowouts
- Explosions
- Fires (facility and surrounds)
- Unplanned plant upsets and shutdowns
- Natural disasters and their implications on operations for example floods, earthquakes, lightning, and
- War and sabotage.

Plans for all seismic, drilling and production operations should incorporate measures to deal with the above potential emergencies that threaten people, the environment or property. Worldwide, the industry improved its operations and reduced its impact on the environment, especially in the last 20-30 years, partially driven by the activism of environmental organisations, and accompanying increased awareness by the public government regulations. For example, thanks to drilling technology improvements such as horizontal drilling, the production footprints are much smaller than they were in the past. Instead of building roads to production fields, work crews are transported via helicopters in ecologically sensitive forest areas. Almost all human activity has an impact on the environment; industrial operations such as oil and gas exploration, production, transportation and consumption are more likely to have an impact by their very nature and size. Through prudent operational standards and closely monitored fair regulations, these impacts can be minimised and the benefits of these resources can be better enjoyed by the society.

3.12 Collaboration between Ghana and other stakeholders in petroleum and natural gas exploration: The establishment of the WAGP project

The West African Gas Pipeline (WAGP) is a regional energy infrastructure project for West Africa. When completed it will be the first cross-border pipeline in the sub-region to cross four international borders.

The Project aims to construct a new high pressure natural gas pipeline, which will supply natural gas from Nigeria to markets in Benin, Ghana, and Togo.



The gas to be transported in the WAGP will be produced and processed in the western part of the Niger Delta in Nigeria. From there, it will be transported via an existing high pressure gas pipeline, the Escravos-Lagos Pipeline System ("ELPS"), to the existing terminus of that system near Lagos, Nigeria, where the WAGP will commence.

From that point, the WAGP will run about 56 km onshore along the Nigerian coast, and from there straight into the sea. From there it will run in a westerly direction roughly parallel to the coast, generally about 15 to 20 km offshore, in water depths ranging from about 15 to 70 metres. The initial construction of the WAGP will terminate at Aboadze in Western Ghana, the site of the Takoradi Thermal Power Station.

Lateral pipelines will be laid, to permit natural gas to be delivered along the way, at regulation and metering stations to be situated at landing points at Cotonou in Benin, Lomé in Togo, and Tema (near Accra) in Ghana. The total length of the new pipeline will be approximately 678 km, including the length of lateral pipelines.

The estimated initial construction cost of the WAGP is US\$580 million, and prior to commencing construction the sponsors of the Project will have spent about \$70 million. This construction cost estimate has been determined via a competitive bidding process.

The initial installed capacity will be about 210 million standard cubic feet a day (MMscfd), (about 6 million cubic metres per day). In addition, the pipeline will be sized to cater for expansion to meet anticipated future growth in demand, up to a maximum capacity expected to be about 460 MMscfd about 13 million cubic metres per day. The cost of the several stages of expansion to achieve maximum capacity will be approximately \$70 million.

An investment decision to construct the pipeline was taken in December 2004. The first gas from the pipeline is in December 2006.

3.13 Objectives and importance of the WAGP project to Ghana and West Africa

The objectives and importance of the WAGP for the sub-region can be summarised as follows:

- A source of cost-effective, secure, clean and reliable energy for West Africa
- Provides a foundation to facilitate regional economic growth and development; and proves that economic integration can work for all
- Provides an infrastructure to stimulate further foreign investment
- Displaces liquid fuels in power generation and consequently contributes to reduction of emission of greenhouse gases in the region, and
- Contributes to overall programme of gas flare reduction in Nigeria.

Other benefits of the project can be enumerated as follows:

- The establishment of infrastructure as a catalyst for foreign direct investment in sustainable development of new West African industries
- Enhancing the regional environment by substituting natural gas for less desirable fuels while reducing gas flaring associated with oil production in Nigeria
- Establishing a new level of regional cooperation and economic integration to enhance regional stability and cultivation of ECOWAS as a regional economic cooperative agency

- A low cost, sustainable fuel (and electricity) solution for Benin, Ghana, and Togo
- Providing Nigeria and investors in Nigeria an additional commercial market for gas
- Significant economic benefits from the construction phase for the participating countries
- Significant ongoing tax and other benefits for the participating countries
- Technology transfer, both in terms of technical facilities and in terms of the management and regulation of regional projects.

Particular identifiable benefits are as follows:

Construction Phase Benefits

It is estimated that approximately US\$75 million will be spent directly in the four countries during the construction phase.

In addition, the project is expected directly to create about 450 jobs in the region during the construction phase.

Net Benefits of the Project to the Countries

An Economic and Financial Assessment of the West African Gas Pipeline Project undertaken by IPA Energy Consulting of the United Kingdom for the World Bank **indicated** key benefits to the States as follows:

Benefits Countries	NPV High Scenario	NPV Low Scenario	Saving from Fuel Switching	WAPCo Taxation	WAPCo Dividend to Shareholders
Ghana	\$600m	\$340m	\$223m	\$ 78m	\$ 39m
Togo	\$240m	\$183m	\$151m	\$ 27m	\$ 5m
Benin	\$170m	\$126m	\$ 93m	\$ 28m	\$ 5m
Nigeria	\$240m	\$223m	\$ 54m*	\$109m**	\$ 59m

*This is from Gas Sales and Transport revenue and not from fuel switching.

** This is a cumulative figure from Upstream Taxation and Income Tax from WAPCo.

Other Benefits

In addition, the International Project Agreement provides for the existing shareholders in WAPCo to sell down 25% of their investment for the benefit of citizens of the region.

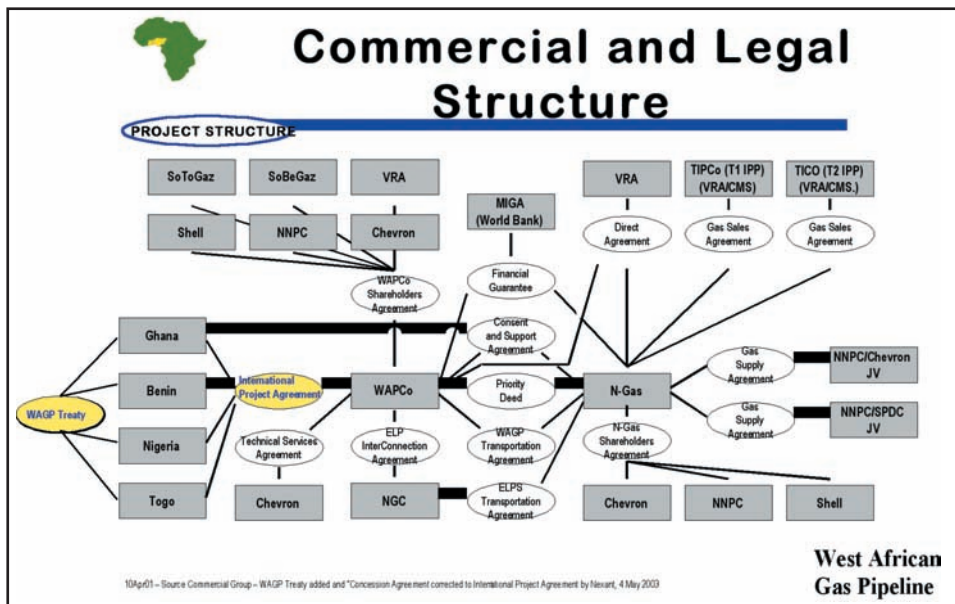
The project is expected to directly employ about 100 people during the operations phase.

3.14 Structure and organisation of the WAGP project

For effective management of the project, it has been organised into the following phases:

- **Conceptual Phase (1992-1995):** This was the pre-feasibility stage of the project when a study was undertaken by Bain e Associati which showed the possibility of the construction of a gas Pipeline from Nigeria to Ghana. It was after this study that a Heads of States Agreement among Nigeria, Benin, Togo and Ghana was signed to initiate the West African Gas Pipeline Project (WAGP).
- **Feasibility Phase (1998-1999):** The Sponsors invested in an Engineering Feasibility Study (EFS) that established the commercial and technical viability of the project. The Sponsors were designated Project Developers after the EFS.
- **Definitional Phase (1999-2004):** The findings of the EFS were fine-tuned and agreements reached with the governments of the participating countries that culminated in the sponsors taking the Final Investment Decision on the project.
- **Construction Phase (2005-2006):** The Project Developer (Sponsor) will engineer, procure and construct the pipeline.
- **Operation Phase (2007-):** The final phase of the project when the pipeline delivers gas to consumers.

A commercial and legal structure of the project is provided below:



NNPC	–	Nigeria National Petroleum Corporation
NGC	–	Nigeria Gas Company
VRA	–	Volta River Authority
WAGPCo	–	West African Gas Pipeline Company
N-Gas	–	Collective name for the gas sellers from Nigeria comprising Shell, Chevron & NNPC
SPDC	–	Shell Petroleum Development Company

The West Africa Gas Pipeline Company (WAGPCo) is comprised of:

Chevron	(36.7%),	Managing Partner
NNPC	(25%)	
Shell	(18%)	
VRA	(16.3%)	
Ben Gaz SA	(2%)	
Société Togolaise de Gaz SA	(2%)	

3.15 Gas utilisation options for Ghana

Natural gas has been recognised for a long time as an environmentally attractive fuel by those close to the gas industry but in recent years environmental issues have generated discussion about the relative merits of fuels among a much wider range of experts. Natural gas appears to be gaining an increased share of the market because of its availability, environmental advantages and efficiency in use.

Studies conducted reveal that industrial gas demand from small and medium-size consumers can only materialise if a gas distribution company is put in place. Gas for power generation is judged to be by far the major consumer of gas and indeed gas usage for power generation at the Aboadze Power Station underpins the whole of the WAGP Project.

Other possible uses of gas from the WAGP are limited as it is free of heavy hydrocarbons, liquids and water and is therefore ideally suited only as fuel for power plants and industrial applications.

3.16 Proposed market overview

Purvin and Gertz adopted an essentially macro-economic approach making use of probabilistic methods in developing projections of the market, having regard to exogenous economic variables such as the expected progression of economic growth, likely evolution of national trading patterns. A scenario approach was adopted with respect to Ghana, Togo and Benin.

The broad picture that emerges from the Purvin and Gertz report is that Ghana will be the principal consumer of gas. Ghana's share of the three countries' demand is estimated at about 85%, with the electricity generation sector accounting for the bulk of national consumption.

Some industrial projects are identified in the Purvin and Gertz report that could require the use of natural gas. They are:

- Iron and steel manufacture, Takoradi
- Manganese ore processing, Tarkwa
- Bauxite processing, Nyinahin
- Limestone clinkerisation, Buipe
- Salt recovery and allied processes, Tema
- Poly Vinyl Chloride (PVC) manufacture, Tema

The report however emphasises the fact that each of these projects would use gas only if the gas price is competitive with the fuel oil price.

3.17 Implementation and monitoring of WAGP

The implementation of the WAGP is guided by the terms of the following under-listed documents that have been duly executed by the States and the Sponsors.

1. Treaty

Implements the agreement between the States to facilitate the project and creates the mechanisms for WAPCo to seek review of decisions made by the Director General of the WAGP Authority, the Council of Ministers and the WAGP Authority's Board of Governors.

2. International Project Agreement (IPA)

Implements the commercial agreement between the states and WAPCo. Contains the investment regime for the project including the special tax regime, licenses and permits, environmental assessments and project construction schedules.

3. Enabling Legislation

Different set for each country to implement the project.

4. Gas Transportation Agreements (GTA)

Gas Transportation Agreements will be signed by shippers of gas, such as N-Gas. Standard Gas Transportation Agreements is being negotiated and will comply with the Access Code that is being finalised.

5. Gas Sales Agreements (GSA)

Gas Sales Agreements are commercial agreements entered into by N-Gas for the sale of gas to Shippers.

Under the GSA negotiations, the following issues have been considered. The State (s) shall:

- (i) guarantee the performance obligations of the Buyer or Shipper (including, without limitation, payment obligations in Foreign currency) to the Seller and/or a Shipper and/or the Company, as the case may be; and/or
- (ii) procure the provision of credit support for the obligations of that enterprise that is acceptable to the Seller, the Shipper or the Company, as the case may be.

6. Interconnection Agreement with ELP System

The Interconnection Agreement specifies the standard of service and guarantees on performance for the interconnection with the Escravos-Lagos Pipeline. The project is reliant on the ELP system delivering gas from the fields to the start of the WAGP.

For the purposes of monitoring and regulating the project an Authority and the following processes and procedures have been put in place:

- **Role of the WAGP Authority**

The Treaty provides for the establishment of the WAGP Authority to monitor and regulate WAGPCo's activities. The WAGPA has a triple role: representation, facilitation and regulation. This role is detailed in the Treaty. Individual states keep a traditional role in some key areas like environment, permitting and taxes, but should act on the basis of the harmonised rules and regulations of the IPA.

The IPA gives the WAGP Authority important rights of audit and there are two key documents that will require its approval – the Pipeline Development Plan and the Access Code.

- **WAGP Regulations**

The regulations will govern the operation of the pipeline including financial penalties for WAGPCo's defaulting in performance of its obligations under the IPA. WAGPA Regulations are prepared by the WAGPA in consultation with WAGPCo. Each State will adopt the Regulations according to provisions in the Enabling Legislation.

- **Rules of Procedure**

The Rules of Procedure are described in the Treaty and are adopted by Ministers from the States to govern proceedings conducted before the WAGP Authority.

- **Access Code**

An Access Code being negotiated will set out the terms for third party access to and use of the WAGP. The Access Code will be subject to approval by WAGPA and will not come into effect until approximately 10 years from the date the pipeline commences operations or until a throughput of 200 MMscfd is attained.

3.18 Progress to date of WAGP

With the Final Investment Decision (FID) taken by the sponsors the project has moved from the Definitional Phase, subject to a few conditions precedent being met, to the Construction Phase.

Coming this far, the following key conditions for the project to materialise have been met to date:

- The project Treaty has been signed and ratified by all the States
- The International Project Agreement (IPA) has been ratified by all the States
- The foundation gas chain agreements, e.g., Gas Sales Agreement (GSA), Gas Transportation Agreement (GTA), Gas Purchase Agreement (GPA), ELPS Interconnection Agreement have all been accomplished
- Enabling Legislation has been passed in all four States
- Land Acquisition for the WAGP Right of Way (ROW) and stations/ facilities has been achieved in all four countries
- The Pipeline Development Plan (PDP) has been negotiated and approved by the appropriate State Agencies
- The World Bank Guarantee Support Agreement has been signed

- Environmental Permits for the project have been obtained in all the States as per their respective laid down procedures
- The Final Investment Decision (FID) has been taken by the sponsors
- Major construction bidding activities have been completed
- EPC contracts (onshore EPC, offshore EPC, offshore concrete weight coating & line pipe procurements) have been executed with vendors.

Construction of the pipeline began in early 2006.

3.19 Evaluation of WAGP

IPA Energy Consulting conducted an Economic and Financial Assessment of the WAGP on behalf of the World Bank and provided the following summary conclusions after their evaluation of the project:

- The project is the best alternative of supplying Ghana with natural gas
- Gas demand forecast is robust
- The WAGP tariff structure is innovative and sound
- Gas price components are transparent and reasonable
- All equity financing is unlikely to change
- The economics are robust under a variety of market conditions
- The benefits are distributed broadly equitably among participants.

3.20 Policy issues / alternatives and debates of WAGP

The main policy issues for WAGP that the States had to grapple with are contained in the objectives that the IPA set out to address, namely:

- Defining a harmonised, consistent fiscal (tax and duty) and sound regulatory regime access across all four States;
- Defining the basis for transportation tariffs and access;
- Defining WAGPCo's condition for the construction and operation of the West African Gas Pipeline;
- Defining how the WAGP Authority, representing the States, is to monitor and regulate WAGPCo's activities.

On gas delivery to the States, the World Bank study that was commissioned looked at the following alternatives and made the observations below:

- **Alternative Pipeline Route**

1. Either more expensive or without project sponsor
2. Onshore routes require considerable way-leaves and resettlement activity.

- **Liquefied Natural Gas**

1. Existing LNG volumes pre-sold to Europe and North America in 20 year contracts
2. New development would require a long time
3. Dedicated gas/re-gas terminal will be more capital intensive than WAGP.

- **Compressed Natural Gas**

1. May be cost competitive
2. Untested technology (CNG is being widely used as transport fuel for fleets in the USA, Europe and South Asia)
3. No project sponsor.

Below are some of the issues of debate that have been in the public domain about certain aspects of the project.¹³ Explanations have been offered on each issue raised.

1. Control of Company Decisions

“Ghana has little control over decisions taken by the Company (WAGPCo)”

- Ghana has a 16.3% share of the Company, two representatives on the Board of the Company and one or more positions in the executive management.
- The Company’s headquarters are based in Accra.
- Control of the Company by Ghana would require a larger investment. A 50% control would necessitate Ghana investing \$290 million.
- Ghanaians and other citizens of the four States can have priority access to up to 25% of the Company’s shares (Art. 6.6 of IPA).
- Company decisions are subject to the contractual and regulatory provisions of:
 - Ghana Law
 - The Treaty
 - The IPA
 - The WAGP regulations
 - The Rules of Procedure
 - The Access Code
 - The Pipeline Development Plan, and
 - The Environmental Management Plan.

These documents do not give the Company much latitude in its decisions. Moreover, Ghana’s interests are protected by the Fiscal Review Board and the WAGP Tribunal.

2. WAGPCo’s Rate of Return

“WAGPCo’s rate of return should not go below 15%...”

- WAGPCo’s minimum rate of return is 12%. That is based on the foundation market.
- WAGPCo’s rate of return, if the Mid-Market Forecast materialises, will be 15%. If the market becomes better than the forecast, then WAGPCo may get more than 15%, but the buyers will also benefit from lower tariffs.

¹³ The issues discussed here are typical of questions raised in public forums and workshops, including those hosted by the Resource Centre.

3. Insurance for the Pipeline

"Insurance cover for the pipeline has not been determined as sufficient"

- Insurance for the pipeline covers more than the cost of the highest damage that can be reasonably anticipated.
- In any case, WAGPCo remains responsible for the transport of gas, therefore for the repair of the pipeline.
- If the insurance cover was higher, which again is not necessary, this would result in higher insurance cost, therefore higher tariffs, which is not in Ghana's shorter term interest.

4. Scope of Collusion between the "other" Shareholders of WAGPCo

"There is a great scope for collusion between the other shareholders of WAGPCo and their affiliates.... This could work to Ghana's disadvantage as ... the cost of construction through these subcontracts is passed on through the gas price to VRA..."

- The cost of the pipeline is the addition of the "Major Contracts", which represents about 70%, and the "Owner's cost", which represents about 30%.
- The Major Contracts have been subject to an international competitive bid process in which contenders were not affiliated with WAGPCo's "other shareholders".
- The owners' costs are development costs, engineering and construction management, WAPCo establishment, personnel training and insurance. When these costs involve shareholders affiliates, including VRA, they are under the form of individual man-days and have been audited.

5. Government of Ghana guaranteeing VRA

- The IPA provides for the Government of Ghana to guarantee VRA performance obligations.
- VRA obligations, however, are not part of the IPA and are subject to the ongoing negotiations between the Government negotiation team and N-Gas.

6. Agreements, Treaty and Enabling Legislation

"Query why the project is governed by a variety of contracts as well as legislation. The Agreements are comprehensive. The legislation, in the form of a Treaty and Enabling Legislation etc. appears superfluous..."

- The Treaty is the core of the solidarity of the States in the Project. It creates the framework of the harmonisation of laws, rules and regulations without which this four states cross-border project would not have been possible.

- The various contracts are the results of the “unbundling” of the various functions intervening in the project between producers, shippers, transporters, and buyers. They allow a better control over each of the functions and actors.
- Highly regarded international experts advised the States in building the institutional, legal and contractual structure of the project.

7. Abandonment of the Pipeline

“There is no compensation payable by the Company in that event”

- If the Company abandons the pipeline it will become the property of the States and if the pipeline is still functioning, there will be an opportunity for the tariffs to become much lower. The States have six months to prepare and find an operator for the pipeline, which appears to be reasonable.
- Should the Company have to pay compensation upon abandonment, a provision to that extent would have to be included in the Company’s costs, resulting in higher tariffs. This would not be in the interest of the States.

8. Ownership of the Company vs. Payment by VRA

“Ownership of the pipeline belongs to the Company, although the construction of the pipeline will be paid for primarily by VRA”

- VRA will not pay the construction costs. The Company shareholders (Chevron, NNPC, Shell, VRA, SotoGaz (Société Togolaise de Gaz SA) and SobeGaz (Société Ben Gaz SA) will pay. VRA will pay for the cost of transporting the gas into the pipeline. If VRA wishes to acquire ownership of the pipeline, VRA should increase its share in WAGPCo.
- The deal between the Company and the States is a BOO (build-own-operate) and that has been the understanding since the beginning of the Project. Therefore, except in the case of sale or abandonment, the Company will remain the owner of the pipeline.
- However, the IPA Tariff Methodology (Clause 15.5 of the IPA) provides conditions that would allow a substantial decrease of the Tariffs at the end of the Primary Term. That is the way for Ghana to derive benefits from payments made by VRA and other buyers.

9. Imbalance between Breaches by States and by the Company

“There is great imbalance between breaches ... by the States and breaches... by the Company”

- Breaches by Company will be subject to penalties in the WAGP Regulations. Those are currently negotiated.
- Breaches by the States: compensation to the Company has to be considered in relation to the huge investment made by the Company (\$580 million).

10. Termination by the States in case of default by the Company

“Even where the Company has defaulted and the States wish to terminate the IPA, they can only do so if various conditions are satisfied, some of which may not be in Ghana’s control”

- Above comments do not state which condition would not be suitable.

11. Termination in case of Company’s Default

“When the States terminate the contract ... as a result of the Company’s default, it is the States who have to pay the Company compensation...”

- Company will be penalised for defaulting as per the WAGP Regulations.
- Again, the issue of the Company paying additional compensation has to be considered in regard to the huge investment made by the company, which is a “sunk” cost to it, vis-a-vis the benefit of the States acquiring the ownership of the pipeline.

12. Waiver of Immunity by Ghana

“Ghana would waive immunities on all her assets so far as her contractual obligations to the WAGP are concerned”

- Clause 43.2 of the IPA deals with Waiver of Immunity applying to all four States. Such waiver involves State assets and revenues, and provides for certain exceptions.
- Clause 10.2 of Schedule 23 of the IPA (Ghana Legislative Outlines) states “VRA may charge its assets and revenues ... as a security to the performance of its payment obligations ...”.

13. Waiver of Immunity by Nigeria, Benin and Togo

“Unlike Ghana, Nigeria, Benin and Togo have waived their immunity on only some of their assets”

- Clause 43.2 of the IPA as above referred applies to all four States.
- In order to secure the application of the clause, similar provisions are included in the Legislative Outlines of Ghana and Nigeria (Security of Assets, Guarantee and Immunity, pp. 236 and 246 of the IPA, respectively).
- For Benin and Togo, similar clauses are not inserted in their respective Legislative Outlines. The reason is that these countries laws already provide for dispositions having the same purpose.

Take or Pay Obligations

"Take or Pay obligations... create a ready market"

- Take or pay contracts provide surety for high risk projects. Developers absorb the sunk cost and thus have no negotiation power on shipping tariffs.
- All privately built pipelines are subject to Take or Pay at inception. It is only when the Pipeline is at full capacity that different contractual terms are negotiated. WAGP will begin with 25-30% of its capacity filled, and will reach 100% only when nearing the end of the 20-year Primary Term.
- The Pipeline Development Plan will provide an option (the "Ramp Up Scenario") to deal with a late or no VALCO return in the Market. This option was introduced to mitigate the negative effect of the combination of a lower market with the Take or Pay.

14. Cases where a "new Treaty" would be required

"Even technical modifications that might be found appropriate in the future will have to be subject to further treaties"

- Technical modifications will not require a "further treaty". They will be addressed through:
 - An amendment to the Treaty; or
 - An amendment to the IPA; or
 - A modification to the Regulatory Documents (PDP, Access Code, WAGP Regulations, Rules of Procedures)

Specific:

"The treaty does not even create the prospect of that (extending the Pipeline to Effasu) happening".

- The Pipeline is a private development. Therefore, it is the market that creates the "prospect".
- However, it is the duty of the States to provide the institutional and regulatory framework for the market opportunities to materialise. The IPA does just that in Article # 25 - "Pipeline System Enlargement".
- The Article states that this is done through an amendment of the Pipeline Development plan which is a simple procedure.

15. Open Access and Domestic Gas

"Saltpond gas access to WAGP subject to the terms of the Access Code"

- IPA Art. 26.4 gives the same access rights to domestic gas produced by Ghana, Togo or Nigeria as to gas produced by N-Gas shareholders.

- The Access Code is drafted and there is nothing in it that prevents or even limits the rights of domestic gas to access the Pipeline at anytime from the beginning of the Project.

16. Bui Dam as an Alternative

Hydroelectric projects are generally costlier. This is due to the high investment cost. Competitive options to WAGP gas have been evaluated in the Purvin & Gertz Report. The costs compare as follows, in cents / kWh:

•Existing SC Gas Turbine (Takoradi):	4.24 c/kWh (Single Cycle)
•Existing CC Gas Turbine (Takoradi):	2.94 c/kWh (Combined Cycle)
•New CC Gas Turbine (Tema):	4.86 c/kWh (Combined Cycle)
•Bui Dam:	8.50 c/kWh

The cost of power from Bui Dam, including depreciation of the asset, would be about twice as much as the cost of power from the WAGP gas.

3.21 Socio-economic impact of WAGP on energy sector of Ghana

This section discusses what respondents perceive to be the benefits of the West African Gas Pipeline Project. The discussion includes expected economic, political, and environmental benefits. In addition, expectations about the effects of the project on economic cooperation, and the pressing felt needs that may require some assistance by the project are discussed.

Expected Economic Benefits

Table 2 indicates that both industry and households are likely to benefit from the project. This was indicated by 62.3 % of the respondents. On the other hand, 31.3 % of the respondents felt that industry alone would benefit most from the project. It is significant to note that only 6.4% of the respondents were of the opinion that only households would benefit from the project. The responses imply that most people expect the project to enhance industrial production rather than household production and consumption (welfare).

Table 2
Beneficiaries from Output of Pipeline

Beneficiaries	Frequency	%
Household	67	6.4
Industry	327	31.3
Both	650	62.3
Total	1044	100.0

Source: Wayo Seini, A. et al. (2001).

Table 3 shows the perceived benefits of the project to households. Respondents expect the project to provide households with electricity for lighting, energy for cooking, and energy for industry. In addition they expect the project to create jobs and to generate income and growth in the economy. All these expected benefits were indicated by 70 %, or more, of the respondents. About 53 % of the respondents also expect the project to protect the environment.

Table 3
Expected Benefits to Households

Benefits	Frequency	%
Electricity for Lighting	818	78.4
Energy for Cooking	884	84.7
Energy for Industry	833	79.8
Create Jobs	938	89.8
Generate Income	808	77.4
Generate Growth	734	70.3
Protect Environment	562	53.8

Source: Wayo Seini, A. et al. (2001).

The accompanying **Table 4** shows that over 57% of the respondents expect the project to increase the volume of employment highly while about 36% expect employment to increase very highly. Thus the job expectations from the project are very high. Indeed only 1% of the respondents indicated that the project would not impact on the volume of employment at all while only 6.1% expected it to fall.

Table 4
Effect on Volume of Employment

Expected Effect	Frequency	%
Increase Very Highly	374	35.8
Increase Highly	596	57.1
Not At All	10	1.0
Reduce Slightly	64	6.1
Total	1044	100.0

Source: Wayo Seini, A. et al. (2001).

The respondents expect the project to protect the environment by reducing deforestation, air pollution and soil erosion in the receiving countries. **Table 5** shows that most respondents (82%) expect the project to reduce deforestation in the receiving countries, while 51.9% of respondents expect air pollution to be reduced. An insignificant proportion (0.4%) of the respondents expect some reduction in soil erosion.

Table 5
Environmental Benefits for Receiving Countries

Benefit	Frequency	%
Reduced Deforestation	856	82.0
Reduced Air Pollution	542	51.9
Reduced Erosion	4	0.4

Source: Wayo Seini, A. et al. (2001).

Table 6 shows the benefits respondents expect receiving countries, to derive from the project. Lower electricity bills, lower vehicle fuel cost and enhanced regional integration are the main benefits that respondents expect receiving countries to get, as they account for more than 70% of the responses. In addition, respondents expect receiving countries to improve on their balance of payment positions and increase their self-reliance in power supply.

Table 6
Benefits for Receiving Countries

Economic Benefit	Frequency	%
Lower Electricity Bills	825	79.0
Lower Vehicle Fuel Costs	778	74.5
Imprvd. Balance of Payment	594	56.9
Imprvd. Regional Integration	743	71.2
Increase in Self-Reliance	575	55.1

Source: Wayo Seini, A. et al. (2001).

On the other hand, the respondents expect the supplying country (Nigeria) to derive some benefits from the project. In **Table 7** about 84% of respondents indicated that Nigeria stands to make foreign exchange earnings from the project. They also expect Nigeria to create new jobs (76.5%), accrue tax revenue (67.0%) and experience industrial growth (63.9%).

Table 7
Benefits for Supplying Country

Benefit	Frequency	%
Foreign Exchange	876	83.9
New Jobs	799	76.5
Tax Revenue	699	67.0
Industrial Growth	667	63.9

Source: Wayo Seini, A. et al. (2001).

Expected Political Benefits

The respondents expect the project to benefit the countries involved by enhancing political stability, improving balance of payments, enhancing integration and promoting self-reliance in energy supply. As shown in **Table 8** a majority of respondents (71.2%) expect the project to enhance integration, while between 55.1% and 59.9% expect the project to increase political stability, improve balance of payments and increase self-reliance in power supply.

Table 8
Expected Political Benefits

Benefit	Frequency	%
Political Stability	625	59.9
Imprvd. Balance of Payment	594	56.9
Imprvd. Regional Integration	743	71.2
Increased Self-Reliance	575	55.1

Source: Wayo Seini, A. et al. (2001).

The accompanying **Table 9** shows that respondents also expect the project to impact positively on sub-regional economic cooperation. While 35.5% of respondents expect the project to have a very high impact on economic cooperation, 60.3% expect the project to have just a high impact. In other words 95.8% of the respondents expect the project to positively influence sub-regional economic cooperation. The need for regional integration has been stressed by most observers, and projects like the WAGP are expected to serve this purpose (IEA, 1995).

Table 9
Effects of Project on Economic Cooperation

Effect	Frequency	%
Very Highly	371	35.5
Highly	630	60.3
Not At All	4	0.4
Don't Know	39	3.7
Total	1044	100.0

Source: Wayo Seini, A. et al. (2001).

Felt Needs and Expectations

It is usual for residents in a project area in a developing country to approach the project developers to help them out with some of their most pressing needs. In **Table 10** social services such as schools and health facilities top the list as indicated by 93.3% of the respondents. This is followed quite closely by infrastructure needs that were indicated by 89.8% of the respondents. Infrastructure needs in Ghana often refer to roads, water, electricity etc. The respondents also expect scholarships for their children (73.3%) and royalties to be paid to them (51.6%).

Table 10
Felt Needs and Expectations of Respondents

Felt Needs	Frequency	%
Develop Infrastructure	938	89.8
Provide Social Services	974	93.3
Scholarships	765	73.3
Royalties	539	51.6

Source: Wayo Seini, A. et al. (2001).

Hopes on Improving Balance of Payments

Hopes on improving the macro-economy and balance of payments were ascertained from the in-depth interviews of stakeholders. It is generally hoped that low cost energy would lead to the expansion of industrial output and therefore growth in the macro-economy. Many businesses depend on an inexpensive, stable, reliable and quality supply of electricity. Industrialisation is the centre of Ghana's accelerated development strategy. Stakeholders are therefore of the general opinion that once the country is assured of an inexpensive and reliable energy supply, the government should be able to push the industrial sector to deliver and thereby contribute to the Gross Domestic Product (GDP).

In addition, it is hoped that the project will lead to a reduction in the importation of petroleum products and thereby lead to foreign exchange savings and improve the balance of payments position of the country. The balance of payments situation would be further improved since reliable energy supply would lead to a reduction in and eventual elimination of energy imports. Tax revenue from an expanded industrial sector would also improve the budget deficits of the country.

Direct Expected Benefits

As indicated earlier on, Tema and Takoradi are the main stations of the pipeline in Ghana. Both metropolitan areas are the main industrial centres of Ghana. They are therefore expected to benefit directly in terms of cheaper energy for industrial use, employment and income generation and new investments, among others. Some industrial concerns expressed their views on the subject during the stakeholder consultations.

Among the industrial concerns covered was the Volta Aluminum Company Limited (VALCO). VALCO is a major consumer of electrical energy in Ghana. The construction of the Akosombo Hydroelectric Power Plant, which supplies the bulk of Ghana's electrical energy was based on the preparedness of VALCO to take up a substantial proportion of the energy generated. However, with the expansion of domestic demand for the use of electrical energy VALCO was compelled to relinquish part of its power intake to VRA for supply to domestic and other consumers. Other stakeholders interviewed also indicated that quite apart from energy being rationed to them, they were worried about unscheduled power cuts (outages).

Most stakeholders expect that if the project is properly carried out, it would need to achieve two things: it would need to reduce the net cost of Ghana's energy needs. This is seen to be one sure way of improving Ghana's trade balance and bringing about

macro-economic stability. It would also need to achieve a net positive impact on the communities or the societies that it will interact with, either physically, geographically or politically. Many of these types of investments can have positive or negative effects on communities. To be successful, there is the need to score on both sides.

Stakeholders expect the project to make electricity generation, transmission and distribution much cheaper than it is now. They expect the implementation of the project to lead to cheaper thermal energy supply that would lead to lower electricity bills and then open up avenues for investments in industry. Lower electricity bills would also cut down the cost of production and lead not only to the establishment of new industries, but also to the expansion of existing ones. The process would ultimately lead to the generation of employment and incomes for the participating countries in particular and the sub-region as a whole. This will naturally improve upon the lives of the people.

Some stakeholders expect the project to encourage the establishment of businesses in the rural areas thereby generating rural employment and incomes. This would probably discourage the influx of rural people into the urban areas in search of non-existent jobs.

For the VRA in particular, the project is expected to increase its capacity and enable it to have some energy in reserve. This would make VRA, a stronger and more reliable organisation. The project is also expected to enhance the international capability and reliability of the VRA. This naturally will make the organisation more creditworthy and give it leverage for loans for the expansion of its services.

The pipeline itself is expected to generate job opportunities in terms of maintenance and security of the pipeline. It is also expected to build a core of local expertise in the energy sector and hence enhance capacity in the sector. Few stakeholders expect the project to directly transfer technology into the country. Technology transfer is expected to accompany industrial expansion.

All the industrial establishments particularly expect that the project will lead to a more reliable and cheaper supply of electricity and thereby reduce their unit cost of energy. VALCO is working closely with VRA and independent power producers to convert natural gas into electricity. This will enable VALCO to utilise its installed capacity. Secondly VALCO would like to replace heavy liquid fuels (bunker fuels, LPG, petrol, diesel, heavy fuel to raise steam) with natural gas.

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APPENDICES

APPENDIX 1 – PNDC Law 64

THE GHANA NATIONAL PETROLEUM CORPORATION LAW, 1983 (PNDC Law 64)

ARRANGEMENT OF SECTIONS

1. Establishment of Ghana National Petroleum Corporation.
2. Objects and Functions of the Corporation.
3. Powers of the Corporation.
4. Corporation to Operate on Sound Commercial Lines.
5. The Board of Directors of the Corporation.
6. Qualification of Members of the Board of Directors, etc.
7. Meetings of the Board of Directors.
8. Functions of the Board of Directors.
9. Delegation of Functions of the Board of Directors to Managing Director
10. Managing Director.
11. Staff.
12. Audit.
13. Internal Auditor.
14. Financial Year of the Corporation.
15. Borrowing Powers of the Corporation.
16. Government Advances and Grants to Corporation.
17. Debt Securities and Sinking Fund.
18. Reserve Fund.
19. Special Foreign Exchange Account.
20. Payment of Taxes by the Corporation.
21. Payment into the Consolidated Fund by the Corporation.
22. Importation of Goods by the Corporation, Etc.
23. Non-Disclosure of Confidential Information.
24. Acts of Corporation in Respect of which Approval of Secretary is Required.
25. Vesting of Assets and Liabilities in the Corporation.
26. Transfer of Staff.
27. Regulations.
28. Transitional Provision.
29. Interpretation.

SCHEDULE

IN pursuance of the Provisional National Defence Council (Establishment) Proclamation, 1981 this Law is hereby made:

Section 1—Establishment of Ghana National Petroleum Corporation.

- (1) There is hereby established a body corporate to be known as the Ghana National Petroleum Corporation (hereafter referred to in this Law as "the Corporation").
- (2) The Corporation shall have perpetual succession and a common seal and may sue and be sued in its corporate name.

- (3) The Corporation may for and in connection with the carrying out of its objects, acquire, hold and dispose of movable and immovable property and may enter into any contract or other transactions.
- (4) Where there is any hindrance to the acquisition by the Corporation of any property, such property may be acquired for the Corporation under the State Property and Contracts Act, 1960 (CA 6), or, as the case may be, under the State Lands Act, 1962 (Act 125), and each such Act shall, as the case may be apply to any such acquisitions with such modifications as may be necessary to provide for the vesting of the property acquired thereunder in the Corporation and for the cost of such acquisition to be defrayed by the Corporation.

Section 2—Objects and Functions of the Corporation

- (1) The objects of the Corporation are to undertake the exploration, development, production and disposal of petroleum.
- (2) Without limiting the generality of subsection (1) of this section the Corporation shall:
 - (a) promote the exploration and the orderly and planned development of the petroleum resources of Ghana;
 - (b) ensure that Ghana obtains the greatest possible benefits from the development of its petroleum resources;
 - (c) obtain the effective transfer to Ghana of appropriate technology relating to petroleum operations;
 - (d) ensure the training of citizens of Ghana and the development of national capabilities in all aspects of petroleum operations; and
 - (e) ensure that petroleum operations are conducted in such manner as to prevent adverse effects on the environment, resources and people of Ghana.
- (3) Subject to the provisions of this Law and any enactment for the time being in force the Corporation may:
 - (a) advise the Secretary and the National Energy Board on matters relating to petroleum operations;
 - (b) engage in petroleum operations, either alone or in association with others;
 - (c) enter into petroleum exploration and production agreements and other petroleum contracts providing for the assistance, participation or co-operation of contractors in connection with petroleum operations;

- (d) either alone or in association with others, buy, sell, trade, store, exchange, import or export petroleum and for this purpose, acquire or operate any installations, facilities or means of transportation;
- (e) engage in research and development programme related to petroleum; and
- (f) engage in such other activities, either alone or in association with others, as may be necessary or desirable for the carrying out of petroleum operations.

Section 3—Powers of the Corporation

The Corporation shall for the attainment of its objects under section 2 exercise the following powers:—

- (a) with the approval of the Secretary, form subsidiary and affiliate companies, branches or agencies in or outside Ghana to carry out activities which the Corporation is authorised to undertake;
- (b) enter into contracts and agreements with individuals or firms in or outside Ghana and with the approval of the Secretary purchase or own shares in other companies engaged in activities related to the objects of the Corporation or sell or transfer such shares;
- (c) purchase, lease, establish, complete, expand, repair and manage such factories, plants, installations and facilities as are necessary in connection with the exploration, development, production and disposal of petroleum and subject to such approval as may be required by any enactment, provide and manage road, marine and aviation communications as well as means of transport and other facilities;
- (d) to execute service or work contracts or consultancy agreements with firms or individuals, either Ghanaian or otherwise;
- (e) to own patent rights and to acquire licences and leases and the right to obtain and use any kind of information concerning inventions, designs and processes relating to the petroleum industry;
- (f) to execute agreements with purchasers for the export of crude oil and natural gas;
- (g) where expedient, to employ agents or contractors to carry out petroleum operations on its behalf;
- (h) to establish welfare and provident funds for the benefit of its employees; and

- (i) to do such other things and perform such other functions as may be necessary or expedient for the purpose of attaining its objects and carrying out its activities.

Section 4—Corporation to Operate on Sound Commercial Lines

- (1) The Corporation shall conduct its affairs on sound commercial lines and, in particular, shall take all necessary steps to ensure that, taking one year with another, its revenues are sufficient to produce on the fair value of its assets, a reasonable return.
- (2) In determining what constitutes a reasonable return, the Corporation shall take into account all relevant economic and financial considerations, including but not limited to the need to generate net operating income in an amount sufficient:
 - (a) to meet interest payments on borrowings and to provide for the repayment of loans made to the Corporation;
 - (b) to provide for a reasonable proportion of the funds needed for expanding the Corporation's activities and for increasing its working capital;
 - (c) to provide reserves for replacement of fixed assets and equipment, expansion or other purposes as required under section 18 of this Law and to the extent that the Board of Directors of the Corporation may deem necessary;
 - (d) to provide for contributions to any welfare or provident fund established by the Corporation; and
 - (e) to make sure payments into the Consolidated Fund as may be required under section 21 of this Law.

Section 5—The Board of Directors of the Corporation

- (1) The governing body of the Corporation shall be a Board of Directors which shall consist of:
 - (a) a Chairman appointed under paragraph (c) of this subsection;
 - (b) the Managing Director of the Corporation;
 - (c) six other persons appointed by the Council on the advice of the Secretary, one of whom shall be appointed as Chairman.
- (2) No person shall qualify for appointment as a member of the Board of Directors unless he is qualified in terms of section 6 of this Law.

- (3) The Chairman and the other members to be appointed under subsection (1)(c) of this section shall be appointed from among persons who by virtue of their careers in the government or public service or of their specialised knowledge are capable of contributing to the work of the Board of Directors.
- (4) The remuneration of the members of the Board of Directors shall be determined by the Council on the advice of the Secretary.
- (5) A member of the Board of Directors appointed under subsection (1)(c) of this section shall hold office for a term of three years or such shorter term as may be determined by the Council and shall continue in office until a successor is appointed or shall cease to hold office upon his resignation or removal.
- (6) Any such member shall be eligible for reappointment on expiration of his term of office.
- (7) the Council, on the recommendation of the Secretary, may remove any member of the Board of Directors from office before the expiration of his term of office if in the opinion of the Council it is in the national interest to do so.
- (8) A member appointed under subsection (1)(c) of this section may at any time resign his office by giving notice in writing addressed to the Council, and in the event of the death, resignation or removal of any such member another person shall, subject to the provisions of this Law, be appointed in his place to hold office until the expiration of the term of office of such member.

Section 6—Qualification of Members of the Board of Directors etc

No person shall qualify to be appointed a member of the Board of Directors or the Managing Director of the Corporation who:—

- (a) is not a citizen of Ghana;
- (b) has been sentenced to death or to a term of imprisonment exceeding twelve months without the option of a fine;
- (c) has been convicted of an offence involving dishonesty and has not been granted a free pardon;
- (d) has been declared an insolvent or a bankrupt under any law for the time being in force in Ghana;
- (e) is adjudged to be a person of unsound mind.

Section 7—Meetings of the Board of Directors

- (1) All meetings of the Board of Directors shall be held at such time and place as the Chairman may determine but the Board shall meet at least once in every month.
- (2) All meetings of the Board of Directors shall be held upon written notice to all members thereof and the notice shall state the agenda for the meeting.
- (3) The notice shall be delivered to each member of the Board of Directors at least seven days prior to the meeting to which the notice relates unless a majority of the members of the Board of Directors decide to waive the requirements in respect of the notice under subsection (2).
- (4) Subject to subsections (2) and (3) of this section the meetings of the Board of Directors shall be called by the chairman thereof or at the written request of the Managing Director or of any four directors; but when the Chairman is absent the meetings may be convened by the Managing Director.
- (5) The quorum at every meeting of the Board of Directors shall be such number as the Board may determine.
- (6) All decisions of the Board of Directors shall be taken at its meetings and the vote of a majority of the members present at such meetings shall be the act of the Board of Directors.
- (7) The minutes of all meetings of the Board of Directors shall be kept by a Secretary appointed for the purpose by the Board of Directors and shall be signed by the Chairman of the Board of Directors and kept in the custody of the Secretary.
- (8) At every meeting of the Board of Directors the Chairman shall preside and, in his absence, a member appointed by those present shall preside.
- (9) The Board of Directors may adopt rules not inconsistent with this Law for the proper conduct of their meetings.

Section 8—Functions of the Board of Directors

- (1) The Board of Directors shall, subject to the provisions of this Law, have general control of the management, property, business and funds of the Corporation and any other affairs and concerns thereof.
- (2) Without prejudice to subsection (1) of this section the Board shall:
 - (a) submit to the Secretary the Annual Report and the Annual Balance Sheet and the profit and Loss Statement of the Corporation not later than three months following the end of the financial year of the Corporation or such earlier date as may be specified by the Secretary;

- (b) advise the Secretary and the National Energy Board on the terms and conditions for the sale, distribution and export of crude oil and petroleum products;
- (c) prepare and submit to the National Energy Board for review, before the end of each financial year of the Corporation by a date specified by the Board, the budget and work programme for the succeeding financial year;
- (d) approve items of income and expenditure in the budget, subject to such guidelines as may be established by the Secretary;
- (e) adopt regulations concerning employment, retirement, administrative and technical matters, accounting and auditing;
- (f) subject to such guidelines and directives as the Secretary may issue, act as conciliator or appoint arbitrators in the settlement of disputes or claims affecting the Corporation and, in general, take any appropriate action of a legal nature for safeguarding the Corporation's interests;
- (g) execute contracts on behalf of the Corporation;
- (h) recommend to the Secretary the formation of affiliate or subsidiary companies;
- (i) administer the rights and powers vested in the Corporation by this Law;
- (j) administer, invest and utilise the welfare and provident funds of the Corporation's employees, with due regard for the interests of such employees, provided that:
 - (i) the welfare and provident funds of the Corporation's employees shall not constitute part of the Corporation's assets and funds; and
 - (ii) the Board of Directors shall submit to the Secretary an annual comprehensive report on all actions taken with respect to the welfare and provident funds;
- (k) submit proposals to the Secretary with respect to the utilisation of the Corporation's general reserves; and
- (l) do such other acts, not inconsistent with this Law or any other Law as may be expedient or necessary for the achievement of the objects of the Corporation.

Section 9—Delegation of Functions of the Board of Directors to Managing Director

- (1) The Board of Directors may delegate any of its functions under this Law to the Managing Director of the Corporation.
- (2) The Managing Director shall be responsible to the Board for the due execution of any functions delegated to him under subsection (1) of this section.

Section 10—Managing Director

- (1) The Corporation shall have a Managing Director who shall be the Chief Executive of the Corporation and shall, subject to directions of the Board of Directors, be responsible for the day-to-day business of the Corporation, for the implementation of the policy and decisions of the Board of Directors and for the administration, organisation and control of all the employees of the Corporation.
- (2) Subject to section 6 of this Law the Managing Director shall be appointed by the Council on the advice of the Secretary given in consultation with the Public Services Commission and shall hold office for a period of five years upon such terms and conditions as the Council may specify in his instrument of appointment, and may be re-appointed for further period of five years.
- (3) The appointment of the Managing Director may be terminated by the Council by six months' notice or the payment to him of six months' emoluments in lieu of such notice and in addition he shall be entitled to receive all benefits that had accrued to him at the time of such termination.
- (4) The Managing Director may, by writing, addressed to the Council, resign his appointment by giving six months' notice.
- (5) Where the office of the Managing Director becomes vacant the Board of Directors shall notify the Secretary who shall, subject to section 6 of this Law, recommend another person for appointment by the Council.
- (6) A senior officer of the Corporation shall be designated by the Board of Directors to perform the functions of the Managing Director in the event of where the office of the Managing Director has become vacant or the Managing Director is temporarily absent or is otherwise incapable of performing the functions of his office.
- (7) Subject to the general directions of the Board of Directors, the Managing Director may delegate to any senior officer of the Corporation any of its functions under this Law and may impose such conditions with respect to the exercise of such delegated functions as he may think fit, but nothing in this subsection shall be construed so as absolving the Managing Director from ultimate responsibility for any act done by any person in pursuance of any such delegation.

Section 11—Staff

- (1) Subject to the provisions of section 17 of the Provisional National Defence Council (Establishment) Proclamation (Supplementary and Consequential Provisions) Law, 1982 (PNDCL 42) the Corporation shall engage such employees as may be necessary for the efficient discharge of its functions under this Law.
- (2) The terms and conditions of service of such employees shall be governed by regulations made in respect thereof by the Board of Directors under section 27 of this Law.

Section 12—Audit

- (1) The books and accounts of the Corporation shall be audited each year by the Auditor-General or an auditor appointed by the Auditor-General.
- (2) The Auditor-General or the auditor appointed by him shall:
 - (a) ensure that the operations of the Corporation are in conformity with its approved budget;
 - (b) examine the annual balance sheet and profit and loss account of the Corporation and certify that these are in conformity with the Corporation's records and submit a report on the operations of the Corporation to the Board of Directors and the Secretary within three months after the end of the financial year of the Corporation.
- (3) The books of the account of the Corporation and its subsidiary and affiliate companies shall be kept in such form as may be determined by the Board of Directors on the advice of the Auditor-General.
- (4) For the purpose of discharging his duties, the Auditor-General or the auditor appointed by him shall have access, during normal business hours to all books, records, and other documents of the Corporation and also inspect all projects being undertaken by the Corporation.

Section 13—Internal Auditor

- (1) The Corporation shall have an Internal Auditor who shall be appointed by the Board of Directors with the approval of the Secretary upon such terms and conditions as the Board of Directors may determine.
- (2) Subject to the provisions of this Law, the Internal Auditor shall be responsible to the Managing Director for the performance of his functions.
- (3) The Internal Auditor shall, as part of his functions under this Law, at intervals of three months prepare a report on the internal audit carried out by him during the period of three months immediately preceding the preparation of the report and shall as soon as practicable after the preparation of the report, submit the report to the Managing Director.

- (4) The Internal Auditor shall make in the report such observations as appear to him necessary regarding the conduct of the financial affairs of the Corporation during the period to which the report relates.
- (5) The Managing Director shall as soon as practicable after receiving such report forward copies thereof to the Chairman of the Board of Directors and the Auditor-General.

Section 14—Financial Year of the Corporation

The financial year of the Corporation shall be the same as the Government.

Section 15—Borrowing Powers of the Corporation

- (1) Subject to the provisions of subsection (2) of this section the Corporation may borrow sums required for the purpose of meeting any of its obligations or discharging any of its functions.
- (2) The power of the Corporation to borrow money shall be exercisable only on the recommendation of the Secretary and with the approval of the Secretary responsible for Finance as to the amount, source of the loan and the terms and conditions under which the loan may be effected.
- (3) An approval given for the borrowing of any money under subsection (2) of this section may be either general or limited to a particular borrowing and may be with or without conditions.
- (4) The Secretary responsible for Finance may approve the guarantee on such conditions as he thinks fit of the repayment of principal and the payment of interest on any authorised borrowing made under this section.

Section 16—Government Advances and Grants to Corporation

- (1) The Government may from time to time approve advances and grants to the Corporation out of money provided by the Government for that purpose.
- (2) The Council may, acting on the advice of the Secretary, approve such special levies as may be imposed on crude oil imported into Ghana to provide funds for the Corporation during the first five years of its establishment.
- (3) The Corporation shall, at such times and in such manner as the Secretary responsible for Finance may direct, make payments of such amount as may be so directed in or towards the repayment of the advances made to the Corporation under subsection (1) of this section and the payments of interest on any sum outstanding for the time being in respect of such advances at such rate as the Secretary may direct.

Section 17—Debt Securities and Sinking Fund

The Corporation may, with the approval of the Secretary responsible for Finance:—

- (a) create and issue debt securities for the purpose of exercising its borrowing powers under section 15;
- (b) establish a sinking fund for the redemption of any debt securities so created; and
- (c) suspend its contributions to the sinking fund for such periods of time and subject to such conditions as may be approved.

Section 18—Reserve Fund

- (1) The Corporation shall establish and maintain a reserve fund to provide for expenditures which may reasonably be anticipated in the carrying out of the Corporation's long-term plan and the annual work programme approved by the Secretary.
- (2) The management of the reserve fund, the sums to be carried from time to time to the credit thereto, the charges to be made against the fund and any other application of the fund shall be as the Secretary responsible for Finance may approve on the recommendation of the Secretary.

Section 19—Special Foreign Exchange Account

- (1) The Corporation shall, with the approval of the Bank received in foreign exchange by the Corporation.
- (2) The Bank of Ghana, shall supervise and monitor the operation of the special foreign exchange account by the Corporation to ensure that it is in conformity with the approved purposes for which the account was established.
- (3) The purposes for which the special foreign exchange account may be used shall include—
 - (a) repayment of principal and interest due in foreign exchange on any borrowings made under Section 15 of this Law;
 - (b) payment for goods and services imported from outside Ghana;
 - (c) such other payments as are required to be made in foreign exchange in respect of transactions related to the objects of the Corporations.
- (4) The Corporation shall, at the end of every period of ninety days, transfer to the Bank of Ghana from the credit balance of its special foreign exchange account such sums of money as are not required within the succeeding period of ninety days for the purposes specified in subsection (1) of this section.

Section 20—Payment of Taxes by the Corporation

- (1) Except as otherwise provided in this Law, the Corporation shall be liable to pay tax under the appropriate enactment as if it were a company registered under the provisions of the Companies Code, 1963 (Act 179).

Section 21—Payment into the Consolidated Fund by the Corporation

Upon approval by the Secretary of the annual profit and loss account, any surplus remaining after provision for taxes and the reserve fund established under section 18 of this Law has been made shall be transferred to the Consolidated Fund.

Section 22—Importation of Goods by the Corporation etc

- (1) The Corporation may, subject to the requirements of any enactment relating to the importation of goods, import from outside Ghana materials, machinery and equipment that are exclusively required for its operations in Ghana, including component parts of machinery and plants, tools, instruments, spare parts, chemicals, minerals, means of transport, safety, and telecommunications facilities, pipelines and pumps, loading and jetty equipment, part installations, laboratory equipment, and such other items as the Secretary for Finance may from time to time approve.
- (2) All materials, machinery and equipment imported by the Corporation under subsection (1) of this section shall not be liable to customs duties or other taxes and charges, but the Corporation shall be liable to pay handling and warehousing expenses and port dues and charges in respect of such items.
- (3) Any contractor or sub-contractor of the Corporation engaged in petroleum operations shall be exempted from import or export duty and any taxes, charges, fees, duties or other imports other than the normal charges payable in respect of service actually rendered by agencies of the State, with respect to the import into or export from Ghana of plant, material, goods or equipment of any kind which are to be used for petroleum operations and which will, on the conclusion of such operations, become the property of the Corporation or be re-exported from Ghana.
- (4) No materials, machinery or equipment in respect of which an exemption has been granted under subsection (2) or (3) of this section shall be disposed of in Ghana or re-exported outside Ghana by the Corporation, a contractor or sub-contractor of the Corporation without the approval in writing of the Ministry responsible for Fuel and Power.
- (5) All materials, machinery and equipment in respect of which an exemption is granted under subsection (2) or (3) of this section shall not be sold in Ghana unless, prior to such sale, the seller thereof has paid to the Comptroller of Customs and Excise such import duty as he would otherwise have paid in respect of such items if he has not been granted the exemption under subsection (2) or (3) of this section.

- (6) Notwithstanding the provisions of subsection (3) of this section the Secretary responsible for Finance may grant exemption in respect of fees and charges payable in respect of the import or export of goods to be used in connection with petroleum operations if in his opinion such exemption is necessary for the carrying out of the purposes of this Law.
- (7) The personal and household effects other than those specified in the Schedule to this Law of a non-Ghanaian employee recruited from outside Ghana by any contractor engaged in petroleum operations shall not be liable to import duty if such personal and household effects were imported into Ghana within six months after the arrival in Ghana of that employee to assume duty.
- (8) The Secretary responsible for Finance may from time to time by notice published in the Gazette amend the Schedule to this Law.

Section 23—Non-Disclosure of Confidential Information

- (1) No member of the Board of Directors, the Auditor-General or any auditor or an employee of the Corporation shall disclose or divulge any information which is considered by the Corporation to be of a confidential nature to any person other than the Secretary, a member of the National Energy Board or of the Board of Directors or any employee or other appointee of the Corporation in the course of official business.
- (2) In case of violation of subsection (1) of this section—
 - (a) where the offender is a member of the Board of Directors he shall be dismissed from such office by the Council on the advice of the Secretary;
 - (b) where the offender is an employee of the Corporation he shall be dismissed upon approval by the Board of Directors.

Section 24—Acts of Corporation in Respect of which Approval of Secretary is Required

- (1) The approval of the Secretary shall be required for any of the following acts of the Corporation:—
 - (a) entering into petroleum exploration and production agreements;
 - (b) adopting long-term plans;
 - (c) adopting annual budgets; and
 - (d) approving the annual balance sheet and statement of accounts.

- (2) The Secretary may, after consultation with the National Energy Board and with the Board of Directors and management of the Corporation prescribe policy guidelines to be followed by the Corporation in the conduct of its activities, and the Corporation shall comply with such guidelines.

Section 25—Vesting of Assets and Liabilities in the Corporation

- (1) On the coming into force of this Law there shall be transferred to and vested in the Corporation assets and liabilities of the Petroleum Department of the Ministry of Fuel and Power and the Corporation shall exercise such rights and discharge such obligations as are related to these assets and liabilities.
- (2) On or after the coming into force of this Law the Corporation shall be responsible for the discharge of such liabilities and contracts as may have been incurred or entered into by the Petroleum Department before the coming into force of this Law in respect of any of the functions to be discharged by the Corporation under this Law and any matters relating to such liabilities and contracts shall be carried out by the Corporation as if the Corporation incurred those liabilities or entered into those contracts.

Section 26—Transfer of Staff

There shall be transferred to the Corporation such members of staff of the Petroleum Department of the Ministry of Fuel and Power as the Secretary may consider necessary and such members of staff shall, subject to the provisions of this Law, be deemed to be employees of the Corporation.

Section 27—Regulations

Subject to the provisions of this Law the Board of Directors may with the approval of the Council make regulations providing for the conditions of service of the Managing Director and other employees of the Corporation.

Section 28—Transitional Provision

Until the Board of Directors of the Corporation is duly constituted under section 5 of this Law the governing body of the Corporation shall be an Interim Management Committee appointed in accordance with the Interim Management Committees (Public Boards and Corporations) Law, 1982 (PNDCL 6) to perform the functions of the Board of Directors under this Law.

Section 29—Interpretation.

In this Law unless the context otherwise requires:

"affiliate company" means any shareholder of a contractor owning five per centum or more shares in the business of the contractor or any entity which controls, or is controlled by, or is under a common control with, the contractor;

"contractor" means any person, firm, body corporate or other entity which has entered into a petroleum agreement with the State and the Corporation to engage in the exploration and production of petroleum pursuant to the Petroleum (Exploration and Production) Law, 1983;

"Council" means the Provisional National Defence Council;

"crude oil" means hydrocarbons which are solid or liquid under normal atmospheric conditions and includes condensates and distillates obtained from natural gas;

"natural gas" means all hydrocarbons which are gaseous under normal atmospheric conditions and includes wet gas, dry gas and residue gas remaining after the extraction of liquid hydrocarbons from wet gas;

"petroleum" means crude oil or natural gas or a combination of both;

"petroleum operations" means exploration, development, production, transportation and disposal of petroleum;

"petroleum product" means any product derived from petroleum by any refining treatment process;

"Secretary" means the Provisional National Defence Council Secretary responsible for Fuel and Power;

"subsidiary company" means a subsidiary of the Corporation established under the Companies Code, 1963 (Act 179).

SCHEDULE
ITEMS NOT QUALIFIED FOR CUSTOMS EXEMPTION

Foodstuffs and alcoholic or non-alcoholic beverages for human consumption;
Tobacco, tobacco products and smokers' requisites;
Disinfectants and insecticides packed in containers of 10 litre contents or less;
Fuel and lubricating oils;
Medicines;
Soap and other detergents;
Tyres and tubes for passenger cars, motor cycles and motorised or non-motorised bicycles;
Unused leather and leather wares;
Paper and paper articles;
Textiles other than those used for industrial purposes;
Unused clothing and footwear;
Glass and glaziers' requisites;
Hand tools;
Office requisites and office machinery;
Passenger cars for not more than 11 passengers, as well as spare parts and accessories thereof;
Motor bicycles;
Firearms and ammunition;
Office furniture;
Medical instrument;
Sanitary articles;
Unused airconditioners, other than for working spaces;
Unused furniture and other mechanical or non-mechanical appliances, apparatuses and household articles;
Sports and pleasure craft and the engines thereof.

Made this 16th day of June, 1983.

FLT.-LT. JERRY JOHN RAWLINGS

Chairman of the Provisional National Defence Council

Date of Gazette Notification: 5th August, 1983.

APPENDIX 2 – PNDC Law 84

THE PETROLEUM (EXPLORATION AND PRODUCTION) LAW, 1984 (PNDC Law 84)

ARRANGEMENT OF SECTIONS

Section

1. All Petroleum Property of Republic.
2. Exploration, Development or Production of Petroleum.
3. Petroleum Operations to Conform to Best International Practices, etc.
4. Secretary to Prepare Reference Map of Blocks.
5. Corporation to have Right Over all Blocks.
6. Right to Enter Land.
7. Compensation.
8. Non-assignment of Petroleum Agreement.
9. Notification and Appraisal of Petroleum Discovery.
10. Development Plans, Annual and Long-term Production Programme.
11. Application of this Part.
12. Period of Validity of Petroleum Agreement.
13. Review of Terms and Conditions.
14. Relinquishment of Portions of an Area.
15. Minimum Work and Expenditure Obligations.
16. Production of Natural Gas.
17. Participating Interest.
18. Rental Payments.
19. Payment of Tax.
20. Payment of Royalties.
21. Contractor to Transfer Assets to Corporation.
22. Petroleum Subcontracts not Assignable without Consent of Secretary.
23. Obligations of Contractors and Sub-Contractors
24. Rights of a Contractor.
25. Transactions Between Contractor and Affiliates.
26. Auditing.
27. Inspection.
28. Restoration of Affected Lands.
29. Secretary to Request for Information.
30. Exclusion of Exemptions granted under Act 437.
31. Exclusion of Exemptions granted under Act 437.
32. Regulations.
33. Interpretation.
34. Affected Legislation.
35. Transitional Provisions Relating to Prospecting and Mining Licences.
36. Commencement.

IN pursuance of the Provisional National Defence Council (Establishment) Proclamation, 1981, this Law is hereby made:

PART I—PETROLEUM RIGHTS

Section 1—All Petroleum Property of Republic

- (1) Without prejudice to any right granted, conferred, acquired, recognised or saved in this Law to explore for or produce petroleum, all petroleum existing in its natural state within the jurisdiction of Ghana is the property of the Republic of Ghana (hereafter referred to as "the Republic") and shall be vested in the Provisional National Defence Council (hereafter referred to as "the Council") on behalf of the people.
- (2) The PNDC Secretary for Fuel and Power (hereafter referred to as "the Secretary") shall represent the Republic of Ghana in negotiation for and entry into petroleum agreements.
- (3) Any petroleum agreement entered into by the Secretary shall be deemed to be approved by the Council unless the Council within a month of the entry by the Secretary into such an agreement disallows the agreement.
- (4) The entry into a petroleum agreement by the Secretary under the provisions of this section shall be deemed a requisite and sufficient authority over the land in relation to which the terms of the agreement are to be carried out.

Section 2—Exploration, Development or Production of Petroleum

- (1) No person other than the Ghana National Petroleum Corporation established under the Ghana National Petroleum Corporation Law, 1983 (PNDCL 64) in this Law referred to as "the Corporation", shall engage in the exploration, development or production of petroleum except in accordance with the terms of a petroleum agreement entered into between that person, the Republic and the Corporation pursuant to subsection (4) of section 5 of this Law or any other authority granted or recognised under this Law.
- (2) Without prejudice to section 1 of this Law, any person who intends to negotiate for a petroleum agreement for the exploration, development or production of petroleum shall submit an application to the Secretary in accordance with such Regulations and such competitive bidding procedure as may be prescribed.
- (3) Copies of such an application shall be forwarded by the applicant to the National Energy Board, the Lands Commission, the Forestry Commission in cases where forest resources are to be affected by the petroleum operations envisaged, the Public Agreements Board and the Minerals Commission.

Section 3—Petroleum Operations to Conform to Best International Practices, etc

Any operations undertaken under a petroleum agreement or other authority granted under this Law shall be carried out in accordance with such Regulations as may be prescribed and with the best international practices in comparable circumstances relating to exploration and production of petroleum, including secondary recovery and the prevention of and waste of petroleum, so as to maximise the ultimate recovery of petroleum from a petroleum field. Such practices shall include all reasonable steps to secure the safety, health and welfare of persons engaged in these operations and shall be in accordance with any directions given, restrictions imposed or requirements made by the Secretary to ensure compliance with such Regulations as may be prescribed.

Section 4—Secretary to Prepare Reference Map of Blocks

- (1) The Secretary shall prepare a reference map showing areas of potential petroleum fields within the jurisdiction of Ghana, divided into numbered areas and each of which shall be described as a "block".
- (2) Subject to such guidelines as the Secretary may issue in respect of the maximum number of blocks or portions of a block or of different blocks that may be held under a petroleum agreement under this Law, a petroleum agreement may be entered into or authority obtained, in respect of such number of blocks or portions of a block or of different blocks as may be specified in such agreement or other authority.
- (3) The Secretary may from time to time decide to close certain blocks other than those covered by petroleum agreements or other authority provided for under this Law, redefine the boundaries of open blocks, or give notice in the Gazette, or in such other manner as the Secretary deems fit, of the opening of new blocks.
- (4) Any decision of the Secretary to close or redefine the boundaries of open blocks shall not become operative until after the expiration of ninety days after a notice of such closure or redefinition of the boundaries of open blocks has been published in the Gazette or in such other manner as the Secretary shall deem fit.
- (5) Within the said period of ninety days all parties with an interest in any petroleum agreement or other authority for petroleum operations may make representations to the Secretary regarding the decision to close or redefine open blocks.
- (6) No such closure or redefinition of open blocks, shall operate to reduce the area which, at the time of such closure or redefinition, is subject to a petroleum agreement.
- (7) Where a petroleum field extends beyond the boundaries of an area covered by a petroleum agreement or any other authority granted or recognised under this Law,

the Secretary may determine that such petroleum field shall be developed as a single unit and may give appropriate directions to the Corporation or the contractor or any other person concerned.

Section 5—Corporation to have Right Over all Blocks

- (1) Subject to such Regulations as may be prescribed and subsections (3) and (4) of this section, the Corporation shall have a right to undertake exploration, development and production of petroleum over all blocks declared by the Secretary as open for petroleum operations over which no petroleum agreement exists.
- (2) Subject to the provisions of section 35 of this Law, the rights granted to the Corporation under subsection (1) of this section shall not effect any rights granted to any person under any licence or authority given under the Minerals Act, 1962 (Act 126) for prospecting and production before the coming into force of this Law.
- (3) Where the exploration, development and production of petroleum under subsection (1) of this section is carried out by the Corporation not in association with a contractor under the terms of a petroleum agreement, the operations of the Corporation shall be carried out in accordance with such terms and conditions as may be prescribed in the Regulations, and in accordance with a long-term exploration and production programme and annual programme drawn up by the Corporation in respect of each block and approved by the Secretary.
- (4) Where the exploration, development and production of petroleum is carried out by the Corporation in association with a contractor, such contractor shall first enter into a petroleum agreement, in accordance with subsection (1) of section 2 of this Law, with the Republic and the Corporation to specify the terms and conditions under which such petroleum operations shall be carried out. Any such petroleum agreement shall include such provisions as may be required by Part II of this Law.

Section 6—Right to Enter Land

- (1) Subject to the provisions of this Law and such Regulations as may be prescribed, the Corporation or a contractor or subcontractor shall have the right to enter upon any land to carry out petroleum operations.
- (2) Any person holding a title to or an interest in land on which the Corporation or a contractor or sub-contractor proposes to enter and to carry out petroleum operations shall, after consultation with the Corporation, permit the carrying out of such operations:
Provided that,
 - (a) before the commencement of such operations all persons having a title to or interest in the land on which such operations are to be carried out shall be notified of the purpose, nature and location of the proposed operations; and

- (b) any person having a title to or interest in such land who suffers any loss or damage as a result of the petroleum operations shall be entitled to such compensation as may be determined by Law.

Section 7—Compensation.

- (1) The owner or occupier of any land on which the Corporation or such contractor or sub-contractor as the case may be, has carried out petroleum operations, shall apply to the Corporation or sub-contractor for compensation for any disturbance, of the owner's or occupier's surface rights and for any damage to the surface of the land, buildings, works or improvements or to livestock, crops and trees as a result of such petroleum operations.
- (2) Such application for compensation shall be copied to the Secretary and Land Valuation Board.
- (3) The amount of compensation payable under subsection (1) of this section shall, subject to the approval of the Land Valuation Board, be determined by agreement between the parties concerned, or if the parties are unable to reach agreement as to the compensation, the matter shall be referred to the Secretary who shall in consultation with the Land Valuation Board determine the compensation payable.

Section 8—Non-assignment of Petroleum Agreement.

A petroleum agreement entered into under this Law shall not directly or indirectly be assigned, in whole or in part, by the holder of such agreement to another person without the prior consent in writing of the Secretary.

Section 9—Notification and Appraisal of Petroleum Discovery.

- (1) The Corporation or a contractor shall furnish such information as may be requested by the Secretary and submit periodic reports on any exploration carried out under a petroleum agreement in accordance with such Regulations as may be prescribed.
- (2) Where a petroleum discovery is made as a result of such exploration, the Corporation or the contractor, as the case may be shall notify the Secretary and the National Energy Board within a period of thirty days after the date of such discovery and shall, in addition, furnish full particulars in writing of the discovery to the Secretary and the said Board as soon as practicable thereafter, indicating whether such discovery merits appraisal or not.
- (3) The Corporation or the contractor, as the case may be, shall, after indicating that the discovery merits appraisal, prepare and submit to the Secretary and the National Energy Board a programme and time-table to carry out an adequate and effective appraisal of such discovery for the purpose of enabling a determination to be made as promptly as possible whether such discovery constitute a commercial field, and the petroleum agreement shall specify the period for carrying out such appraisal.

- (4) Where a commercial field is established, such field shall be developed promptly by the Corporation or the contractor, as the case may be, in accordance with such Regulations as may be prescribed and with the best international techniques and practices prevailing in the petroleum industry, in order to ensure the most efficient, beneficial and timely use of the petroleum resources concerned.
- (5) Where a contractor declares a discovery to be non-commercial, the area which comprises the geological structure in which the discovery is located shall be relinquished by the contractor

Section 10—Development Plans, Annual and Long-term Production Programme

- (1) The Corporation or a contractor as the case may be, shall submit to the Secretary and the National Energy Board a development plan in respect of any petroleum field to be developed directly by the Corporation or in accordance with the terms of a petroleum agreement and such Regulations as may be prescribed.
- (2) No operations shall commence to implement a development plan unless the plan has been approved by the Secretary.
- (3) The Corporation or a contractor, as the case may be, shall submit for the approval of the Secretary long-term production programmes in respect of any petroleum field to be developed directly by the Corporation or in accordance with the terms of a petroleum agreement and such Regulations as may be prescribed
- (4) The Secretary may direct the Corporation or a contractor, as the case may be, to take necessary and practical steps to increase or reduce the rate at which petroleum is being recovered to such a rate as will enhance the ultimate recovery of petroleum from the field and not to exceed the capacity of existing production facilities in accordance with such Regulations as may be prescribed.

PART II—PETROLEUM AGREEMENTS

Section 11—Application of this Part

This Part shall apply to petroleum agreements entered into by the Republic, the Corporation and a contractor pursuant to subsection (4) of section 5 of this Law.

Section 12—Period of Validity of Petroleum Agreement

- (1) A petroleum agreement entered into under this Law shall be valid for a total period not exceeding thirty years, but such agreement shall terminate at any earlier time

provided for in the agreement and in any case if no commercial discovery of petroleum is made within seven years from the effective date of such agreement or such lesser period as may be stipulated in such agreement.

- (2) The period commencing from the effective date of a petroleum agreement until the date of termination of the agreement if no commercial discovery is made specified in subsection (1) of this section shall constitute the exploration period and such period shall be divided into an initial exploration period and one or more periods of extension.
- (3) Where a discovery of petroleum is made during the last year of the time period specified in subsection (1) of this section for termination of an agreement if no commercial discovery is made, the Secretary may grant an extension of such time period in respect of the reduced area comprising the geological structure in which the discovery is located on such terms and conditions as the Secretary deems fit for the purpose of enabling a determination to be made within such period of extension whether such discovery of petroleum constitutes a commercial field.

Section 13—Review of Terms and Conditions

A petroleum agreement shall provide for a review of its terms at any time any significant change occurs in the circumstances prevailing at the time of the entry into the agreement or the last review of the agreement.

Section 14—Relinquishment of Portions of an Area

- (1) A petroleum agreement shall provide for the relinquishment in a phased manner of portions of an area to which the agreement relates after the expiration of the initial exploration period specified in the agreement or after the extension of any such period.
- (2) Any area relinquished in accordance with the terms of a petroleum agreement shall, in so far as it is possible, be contiguous and compact and of such size and shape as will permit the effective carrying out of petroleum operations in the relinquished area and shall be in accordance with such Regulations so may be prescribed.
- (3) The area to be retained at the end of the exploration period shall, in so far as possible, include the petroleum reservoirs for all discoveries of petroleum which may have been made in the agreement area and shall be of such size and shape as the Secretary shall approve, except as may otherwise be provided in accordance with the terms of a petroleum agreement.

Section 15—Minimum Work and Expenditure Obligations.

A petroleum agreement shall provide for a minimum work and expenditure obligations to be fulfilled by a contractor during the initial exploration period and each subsequent extension of such period.

Section 16—Production of Natural Gas

- (1) A petroleum agreement shall provide that any natural gas produced in association with crude oil may be used in petroleum operations, but such use shall be in accordance with such Regulations as may be prescribed and with good petroleum industry practice and approved production plans.
- (2) Any natural gas produced by a contractor in association with crude oil which is not used in petroleum operations pursuant to subsection (1) of this section and all natural gas produced other than in association with crude oil shall be the property of the Corporation except as may otherwise be agreed upon by the Corporation and the contractor in accordance with the terms of a petroleum agreement.

Section 17—Participating Interest

A petroleum agreement shall provide that the Corporation shall, within a specified period of time from the date a discovery is declared to be commercial, have the option to acquire up to such percentage of the interest in the rights and obligations of such petroleum operations on such terms as may be agreed between the Corporation and the contractor in such petroleum agreement.

Section 18—Rental Payments

There shall be payable to the Republic by a contractor such annual rental charges as may be prescribed by the Secretary except as may otherwise be provided in accordance with the terms of a petroleum agreement in respect of the area to which such agreement relates during the initial exploration period or any extensions of such period.

Section 19—Payment of Tax

A contractor shall, subject to the provisions of this Law, pay company income tax in accordance with the laws of Ghana, except as may otherwise be provided in accordance with the terms of a petroleum agreement.

Section 20—Payment of Royalties

- (1) There shall be payable to the Republic royalty in respect of any petroleum produced in Ghana, except as may otherwise be provided in accordance with the terms of a petroleum agreement.
- (2) Petroleum produced by the Corporation carrying out petroleum operations pursuant be subsection (3) of section 5 of this Law shall be subject to the payment of royalty at such rates as may be prescribed from time to time.
- (3) Petroleum produced pursuant to a petroleum agreement shall be subject to the payment of royalty at such rates as may be specified in such agreement, and the Corporation shall be liable for the payment of such royalty as is due in respect of such petroleum.

Section 21—Contractor to Transfer Assets to Corporation.

- (1) A petroleum agreement shall provide for the transfer to the Corporation of all physical assets purchased, installed, constructed by the contractor for petroleum operations and the cost of which has been included in Exploration Expenditures, provided that the contractor shall have the use of such assets for purposes of operations under a petroleum agreement and shall remain liable for maintenance, insurance and other costs associated with such use.
- (2) Without prejudice to subsection (1) of this section, after termination of petroleum operations in any area, the contractor shall give the Corporation an option to acquire any movable and immovable assets used for such petroleum operations, and the operation of section 28 of this Law may be modified accordingly at the request of the Corporation.
- (3) The provisions of this section shall not require the contractor to transfer to the Corporation equipment or any other assets rented or leased by the contractor which is imported into Ghana for use in petroleum operations and subsequently re-exported there from, and which is of the type customarily leased for such use in accordance with petroleum industry practice.

PART III—RIGHTS AND OBLIGATIONS OF CONTRACTORS AND SUB-CONTRACTORS

Section 22—Petroleum Subcontracts not Assignable Without Consent of Secretary.

A contractor or sub-contractor shall not assign, either directly or indirectly, his rights and obligations under a petroleum sub-contract, in whole or in part, to a third party without the prior written consent of the Secretary.

Section 23—Obligations of Contractors and Sub-Contractors

- (1) A contractor or sub-contractor shall conduct petroleum operations under a petroleum agreement or petroleum sub-contract, as the case may be, with due diligence and efficiency and in accordance with both such Regulations as may be prescribed and with the best international techniques and practices prevailing in the petroleum industry, in a workman-like manner, observing sound engineering and technical practices and using appropriate advanced technology and effective equipment, machinery, methods and materials.
- (2) All data and information obtained by a contractor or sub-contractor as a result of petroleum operations and all geological, geophysical, technical, financial and economic reports, studies, interpretations and analysis prepared by or on behalf of a contractor or sub-contractor in connection with such petroleum operations shall be the property of the Corporation.

- (3) A contractor or sub-contractor shall not retain or export or permit the retention or export of any such data or documents referred to in subsection (2) of this section without the prior approval in writing of the Corporation, and where much data or documents are exported, the sub-contractor shall, at the written request of the Corporation, re-export them forthwith to Ghana.
- (4) Where such interpretations or analysis referred to in subsection (2) of this section are done outside Ghana, copies of the reports thereon shall be forwarded to the Corporation forthwith by the contractor or sub-contractor responsible for such interpretations or analysis.
- (5) A contractor or sub-contractor shall keep all data acquired and any existing data released to him by the State or the Corporation confidential and shall not disclose such data to a third Party without permission from the Secretary except as may otherwise be provided in accordance with the terms of a petroleum agreement or petroleum sub-contract, as the case may be.
- (6) A contractor or sub-contractor shall maintain in Ghana complete and accurate records of all operations carried out by him and also complete and accurate books of account, records and registers relating to such activities.
- (7) A contractor or sub-contractor shall furnish to the Corporation at regular intervals reports on petroleum operations being carried out by him and shall also furnish to the Corporation such data, information or reports as the Corporation may request.
- (8) A contractor or sub-contractor shall furnish the Corporation such performance bonds and guarantees as may be required in accordance with the Regulations and in accordance with the terms of a petroleum agreement or petroleum sub-contract entered into under this Law in order to ensure the fulfilment of the obligations undertaken by such contractor or sub-contractor or the discharge of his liabilities arising out of the operations under such petroleum agreement or petroleum sub-contract and to ensure compliance with this Law and the Regulations.
- (9) A contractor or sub-contractor shall at all times keep the Corporation indemnified against claims arising from the operations of such contractor or sub-contractor brought by third parties.
- (10) A contractor or sub-contractor shall, in accordance with the Regulations and with the terms of a petroleum agreement or petroleum sub-contract, as the case may be, ensure that opportunities are given as far as is possible for the employment of Ghanaians having the requisite expertise or qualifications in the various levels of the operations.
- (11) A contractor or sub-contractor shall not engage in discriminatory practices on grounds of race, nationality or sex in the conditions of service provided for personnel.

- (12) A contractor or sub-contractor shall, as far as practicable, in accordance with the Regulations and the petroleum agreement or sub-contract use goods and services produced or provided in Ghana for his operations in preference to foreign goods and services.
- (13) A contractor or sub-contractor shall, in consultation with the Corporation, prepare and implement, in accordance with the Regulations and in accordance with the terms of any such petroleum agreement or petroleum sub-contract, plans and programmes for training Ghanaians in all job classifications and in all aspects of petroleum operations.
- (14) A contractor or sub-contractor shall while carrying out petroleum operations prepare and implement plans for the transfer to the Corporation of advanced technological know-how and skills relating to petroleum operations but this provision shall not be interpreted to disable the contractor or sub-contractor from protecting their competitive position in the petroleum industry or requiring the Corporation also to take steps to protect such competitive position.
- (15) Except for such sub-contractors as may be exempted from the requirements of this subsection by the Regulations, a contractor or sub-contractor which is not an incorporated company in Ghana under the Companies Code, 1963 (Act 179) shall —
 - (a) register an incorporated company in Ghana under the provisions of the Companies Code, 1963 (Act 179) to be authorised to carry out solely petroleum operations in respect of which a petroleum agreement or petroleum sub-contract has been entered into under this Law and such company shall be a signatory to any petroleum agreement;
 - (b) maintain an office or establishment in Ghana to carry out petroleum operations and shall have in charge of such office or establishment a representative with full authority to act and to enter into binding commitments on behalf of the contractor or sub-contractor, as the case may be; and
 - (c) in respect of such petroleum operations, open and maintain an account with a bank in Ghana.
- (16) A contractor or sub-contractor shall not transfer any share or shares in its incorporated company in Ghana to a third party either directly or indirectly without the written approval of the Secretary if the effect of such transfer would be either to give such third party control of such company or to enable such third party take over the interests of a shareholder who owns five per centum or more of the shares in such company.
- (17) A contractor or sub-contractor carrying out petroleum operations shall maintain at the work site an establishment capable of dealing adequately with fire, oil spills,

blow-outs, accidents or other emergency situations so as to prevent or control such situations and to minimise loss or damage therefrom.

- (18) A contractor or sub-contractor carrying out petroleum operations shall be responsible for any pollution or damage caused by or resulting from such operations as well as pollution or damage caused by or resulting from petroleum operations undertaken by an agent or employee of such contractor or sub-contractor and shall take all necessary measures to remedy any pollution or damage so caused.
- (19) If at any time a contractor or sub-contractor fails to carry out petroleum operations in a safe manner in accordance with the Regulations and with the best international techniques and practices prevailing in the petroleum industry in comparable circumstances, the Corporation may, after giving the contractor or sub-contractor, as the case may be, such notice as may be reasonable in the circumstances, take all measures necessary to ensure safety and may recover the costs and expenses of so doing from the contractor or the sub-contractor.

Section 24—Rights of a Contractor.

- (1) (a) A contractor shall, subject to the provisions of this Law and in association with the Corporation, have a right to carry out petroleum operations and execute such works as may be expedient in the area, the subject of a petroleum agreement.
- (b) The exercise of such rights of the contractor conferred by paragraph (a) of this subsection shall be subject to restrictions in specified areas which shall be prescribed in the Regulations.
- (2) Subject to the provisions of subsection (3) of this section, a contractor shall be permitted to export from Ghana any petroleum which he is entitled under the terms of a petroleum agreement to export.
- (3) Where there is war or other emergency affecting energy supplies, the Secretary may require a contractor to sell all or part of the quantity of petroleum produced at the prevailing market prices to the Republic or any agency of the Republic.

PART IV—MISCELLANEOUS

Section 25—Transactions Between Contractor and Affiliate

Subject to the provisions of this Law, any transaction between a contractor or sub-contractor and an affiliate in relation to petroleum operations to be carried out under this Law shall be on the basis of prevailing international competitive prices and such other terms and conditions as would be fair and reasonable if such transaction had taken place between the contractor or sub-contractor and a non-affiliate.

Section 26—Auditing

An auditor appointed by the Corporation or any person authorised by the Corporation shall have the right at all reasonable times to inspect, test and audit, as appropriate, the works, equipment, operations and financial books of account, records and registers relating to petroleum operations performed by a contractor or a sub-contractor under this Law and to make abstracts or copies of any document pertaining to such operations.

Section 27—Inspection

- (1) The Secretary may authorise any person to inspect any petroleum operations and to ensure that such petroleum operations are carried out in accordance with the provisions of this Law and the Regulations and in accordance with the terms and conditions of any applicable petroleum agreement or petroleum sub-contract.
- (2) Any person authorised by the Secretary under subsection (1) of this section shall have the right at reasonable times to:
 - (a) enter any area, structure, platform, vehicles, installation, vessel, aircraft, facilities, offices or buildings used by the Corporation, a contractor or sub-contractor for petroleum operations;
 - (b) inspect, test and audit, as appropriate, the works, equipment, operations and financial books of account, records and registers of a contractor or sub-contractor or the Corporation relating to or used in such petroleum operations ;
 - (c) take and remove for the purposes of analysis or testing sample of petroleum, water or other substance from a well;
 - (d) inspect, take extracts from, and make copies of any document relating to such operations; and
 - (e) make such examinations and inquiries as are necessary to ensure that the provisions of this Law and the Regulations are being complied with.
- (3) A contractor or sub-contractor or the Corporation, as the case may be, shall provide any person authorised by the Secretary under subsection (1) of this section with all reasonable facilities and assistance to enable the effective and timely performance of the inspection functions under this section.

Section 28—Restoration of Affected Land

After the termination of petroleum operations in any area the Corporation, in the case of operations pursuant to subsection (3) of section 5 of this Law or the contractor, in the case of operations pursuant to a petroleum agreement in accordance with subsection (4) of section 5 of this Law, shall restore the affected areas and remove all causes of damage or danger to the

environment in accordance with the Regulations. Such restoration shall include removal of all property brought into the affected area but no longer required for further petroleum operations, the plugging or closing off of all abandoned wells in such a manner as may be provided by the Regulations; and the conservation and protection of natural resources in such area.

Section 29—Secretary to Request for Information

- (1) The Secretary may, for the purpose of this Law, request in writing any person to furnish him, within such period as may be specified in the request, such information and documents as may be specified therein.
- (2) Any person requested to furnish any information or document under subsection (1) of this section shall comply with the request within the period specified therein.

Section 30—Exclusion of Exemptions Granted Under Act 437

Notwithstanding the provisions of the Investment Code, 1981 (Act 437) relating to the mining industry, the provisions of this Law or of any petroleum agreement or petroleum sub-contract entered into thereunder shall not entitle a contractor or sub-contractor —

- (a) to the exemption from payment of company tax granted under paragraph (2)(b)(i) of sub-part B of Part II of the Third Schedule to the Investment Code, 1981 (Act 437); or
- (b) to the guarantee of extended management control granted under paragraph (2)(b)(ii) of sub-part B of Part II of the said Third Schedule; or
- (c) to the exemption from payment of company tax granted under paragraph (2)(b)(iii) of sub-part B of Part II of the said Third Schedule; or
- (d) to the benefits granted to approved enterprises generally under sub-part A of Part II of the said Third Schedule.

Section 31—Offences and Penalties

- (1) Any person who —
 - (a) undertakes petroleum operations otherwise than in accordance with the provisions of this Law;
 - (b) unlawfully interferes with or obstructs the Corporation or a contractor or sub-contractor or their agents or employees in the exercise of any right under this Law;

- (c) wilfully obstructs, hinders or assaults any other person in the exercise of any right, power or in the performance of any duty under this Law; or
 - (d) otherwise contravenes any other provision of this Law, shall be guilty of an offence and liable on conviction to a fine not exceeding ₪1,000,000.00 and, where the offence continues, to a fine not exceeding ₪1,000,000.00 for each day on which the offence continues or to imprisonment for a term not exceeding six months or both.
- (2) Where an offence is committed by a body of persons —
- (a) in the case of a body corporate, other than a partnership every director or officer of the body shall be deemed also to be guilty of the offence; and
 - (b) in the case of a partnership, every partner or officer of that body shall be deemed to be guilty of that offence;
provided that no person shall be deemed to be guilty of an offence by virtue of this section if he proves that the offence was committed without his knowledge or that he exercised due care and diligence to prevent the commission of the offence, having regard to all the circumstances.

Section 32 – Regulations

- (1) The Secretary may, by legislative instrument, make regulations prescribing all matters that by this Law are required or permitted to be prescribed or are necessary or convenient to be prescribed for carrying out or giving full effect to this Law.
- (2) Without prejudice to the generality of subsection (1) of this section, the Secretary may prescribe regulations for or with respect to —
 - (a) ensuring the safe construction, maintenance and operation of installations and facilities used in connection with petroleum operations;
 - (b) the safety, health and welfare of persons employed in petroleum operations and generally for all necessary safety measures;
 - (c) the prevention of pollution and the taking of remedial action in respect of any pollution which may occur in connection with petroleum operations;
 - (d) the inspection of areas in which petroleum operations are being carried out and of any plant, machinery and equipment within those areas;

- (e) the reporting of and inquiries into accidents arising out of petroleum operations;
- (f) the keeping and inspection of records, accounts, statistics and plans with respect to petroleum operations;
- (g) the relinquishment of portions of areas subject to petroleum agreement;
- (h) the protection of fishing, navigation, and other activities carried out within or in the vicinity of any areas in which petroleum operations are being carried out;
- (i) the making and submission of reports, returns and programmes;
- (j) the standards for petroleum and petroleum products and transportation thereof;
- (k) the rates of royalty payable in respect of petroleum production, the methods of calculation of the amount of royalty and the manner and times of payment thereof;
- (l) the reference map of numbered areas, each of which shall be described as a "block", and guidelines on the maximum number of blocks that may be held under a petroleum agreement by an applicant;
- (m) competitive bidding procedures for petroleum agreements;
- (n) determining the value of crude oil and natural gas;
- (o) requiring the Corporation and any contractor to submit to the National Energy Board and the Secretary their investment programme;
- (p) the conservation of natural resources and the avoidance of waste, whether petroleum or otherwise, of the land to which this Law applies;
- (q) the accounting procedures to be followed and reporting on all petroleum operations;
- (r) the minimum conditions of service for workers engaged in petroleum operations;
- (s) the terms and conditions of petroleum agreements pursuant to subsection (2) of section 2 of this Law;
- (t) the rates or methods of setting the rates at which petroleum and water may be recovered from any well or petroleum reservoir;

- (u) the methods to be used for the measurement of petroleum, water and other substances from a well;
- (v) the pressure maintenance in, or repressuring of, a petroleum reservoir and the recycling of petroleum;
- (w) the terms and conditions under which the Corporation shall undertake the exploration, development and production of petroleum not in association with a contractor pursuant to subsection (3) of section 5 of this Law;
- (x) the specified areas in which the exercise of rights of a contractor under subsection (1) of section 22 of this Law to carry out petroleum operations shall be restricted; and
- (y) the penalties for offences against the Regulations.

Section 33—Interpretation

In this Law, unless the content otherwise requires,—

"affiliate" means any shareholder of a contractor or sub-contractor owning five per centum or more of the shares in the business of such contractor or sub-contractor or any entity which controls, is controlled by or is under common control with, the contractor or sub-contractor;

"contractor" means any person, firm, body corporate or other entity which has entered into a petroleum agreement with the Republic and the Corporation pursuant to subsection (4) of section 5 of this Law;

"crude oil" means hydrocarbons which are solid or liquid under normal atmospheric conditions and includes condensates and distillates obtained from natural gas;

"development" includes the building and installation of facilities for the production of petroleum and the drilling of development wells;

"discovery" means petroleum not previously known to have existed, recovered at the surface in a flow measurable by conventional industry testing methods;

"exploration" means the search for petroleum by geological, geophysical and other means, and drilling of exploration wells, including appraisal wells, and activities connected therewith;

"natural gas" means all hydrocarbons which are gaseous under normal atmospheric conditions and includes wet gas, dry gas and residue gas remaining after the extraction of liquid hydrocarbons from wet gas;

"petroleum" means crude oil or natural gas or a combination of both;

"petroleum agreement" means an agreement entered into between the Republic, the Corporation and a contractor pursuant to subsection (4) of section 5 of this Law for the exploration, development and production of petroleum by the Corporation in association with the contractor;

"petroleum sub-contract" means any contract between the Corporation and a third party or between a contractor and a third party for the provision of services for petroleum operations, but does not include a petroleum agreement;

"petroleum operations" means the exploration, development or production of petroleum;

"petroleum product" means any product derived from petroleum by any refining or treatment process;

"production" means the extraction and disposal of petroleum, including development operations and all other works and services connected therewith;

"Regulations" means regulations made pursuant to section 32 of this Law or pursuant to section 16 of the National Energy Board Law, 1983 (PNDCL 62) or regulations made under the Minerals Act, 1962 (Act 126) in respect of petroleum;

"Republic" means the Republic of Ghana;

"State" means the Government of the Republic of Ghana;

"sub-contractor" means any third party with whom the Corporation or a contractor, as the case may be, has entered into a petroleum contract for the provision of services for petroleum operations.

Section 34—Affected Legislation

- (1) Except as otherwise provided in this Law, the provisions of the Minerals Act, 1962 (Act 126) shall, to the extent that they apply to petroleum, cease to be operative on the coming into force of this Law, and accordingly, any reference in that Act to petroleum shall be deemed to have been repealed.
- (2) Notwithstanding subsection (1) of this section any regulations made under the Minerals Act, 1962 (Act 126) in respect of petroleum shall, to the extent they are consistent with the provisions of this Law, continue in force until amended or revoked under this Law.
- (3) The Petroleum (Exploration and Production) Law, 1983 (PNDCL 68) is hereby repealed.

Section 35—Transitional Provisions Relating to Prospecting and Mining Licences

- (1) Notwithstanding section 34 of this Law any oil prospecting licence or oil-mining licence granted under the Minerals Act 1962 (Act 126) and which is in effect on the coming into force of this Law shall continue to be in operation in accordance with the terms and conditions of such licence for a period of six months following the coming into force of this Law or after such longer period as the Secretary may allow.
- (2) During such period of operation, the holder of any such licence shall negotiate with the Republic and the Corporation for a petroleum agreement over all or part of the area the subject of such licence, and no petroleum agreement relating to any part of such area shall be entered into with any party other than the holder of such licence prior to the expiration of such period.
- (3) Where assets have been acquired for petroleum production under a licence of the kind referred to in subsection (1) of this section, such assets may only be removed from a site after an inspection of the site authorised by the Secretary and an approval in writing of such removal has been granted.
- (4) The petroleum operation relating to any production well in existence before the coming into force of this Law shall not be terminated except with the approval in writing of the Secretary.

Section 36—Commencement

This Law shall be deemed to have come into force on the 1st day of October, 1983.

Made this 1st day of June, 1984.

FLT.-LT. JERRY JOHN RAWLINGS

Chairman of the Provisional National Defence Council

Date of Gazette Notification: 29th June, 1984.

APPENDIX 3 – PNDC Law 188**THE PETROLEUM INCOME TAX LAW, 1987 (PNDC Law 188)****ARRANGEMENT OF SECTIONS****PART I – IMPOSITION OF TAX AND ASCERTAINMENT OF CHARGEABLE INCOME****Section**

1. Charge of tax
2. Ascertainment of chargeable income
3. Deductions allowed in ascertaining chargeable income
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PART XI—MISCELLANEOUS

37. Power to make regulations and prescribe forms
38. Interpretation
39. Repeal and disapplication of other tax legislation
40. Penalties and fines to be paid in currency in which tax is payable
41. Exemption

IN pursuance of the Provisional National Defence Council (Establishment) Proclamation, 1981, this Law is hereby made:

PART I—IMPOSITION OF TAX AND ASCERTAINMENT OF CHARGEABLE INCOME**Section 1—Charge of Tax.**

Every person carrying on petroleum operations shall, subject to the provisions of this Law, pay for each year of assessment a tax on his chargeable income calculated in the manner provided in this Part.

Section 2—Ascertainment of Chargeable Income.

- (1) The chargeable income of any person carrying on petroleum operations for any year of assessment from and after the year of commencement shall be calculated by deducting from his gross income for that year the amounts specified in section 3.
- (2) For the purpose of ascertaining the gross income of the person his income from the sale of petroleum shall be taken into account at selling price actually realised, and in the case of a sale to an affiliate or an export without sale at world market prices established in the manner provided for in the Petroleum Agreement to which such person is party.

Section 3—Deductions Allowed in Ascertaining Chargeable Income.

- (1) For the purpose of computing the chargeable income of any person for any year of assessment there shall be deducted all outgoings and expenses wholly, exclusively and necessarily incurred by such person for the purpose of petroleum operations during the year of assessment including the following:
 - (a) rentals;
 - (b) royalties;
 - (c) sums payable by way of interest, fees or charges upon any money borrowed by any such person, where the Commissioner is satisfied that such interest, fees or charges were payable on capital employed for the purpose of petroleum operations:

Provided that where in the opinion of the Commissioner, the rate of interest, fees or charges payable on such loans, are excessive by reference to the Commercial rate for similar loans generally prevailing at the time the loan was made, the deduction shall be limited to such commercial rate;
 - (d) any expense incurred for repair of premises, plant, machinery or fixtures employed for the purposes of petroleum operations or for the repair or alteration of any implements, utensils or articles so employed:

Provided that if such premises, plant, machinery, fixtures, implements, utensils or articles are employed in part for domestic or private purposes so much of any such expenses as may be determined by the Commissioner to be in respect of such purposes shall not be deducted hereunder;
 - (e) debts directly incurred in the conduct of petroleum operations and proved to the satisfaction of the Commissioner to have become bad or doubtful in the year of assessment in respect of which the chargeable income is being ascertained notwithstanding that such bad or doubtful debts were due and payable prior to the commencement of that year of assessment.

Provided that:

- (i) the deduction to be made in respect of a doubtful debt shall not exceed that portion of the debt which is proved to have become doubtful during the year of assessment nor in respect of any particular debt shall include any amount deducted under the provisions of this section in determining the chargeable income of a previous year of assessment;
- (ii) all sums recovered during the same year of assessment on account of amounts previously deducted in respect of bad or doubtful debts shall for the purposes of this Law be treated as income incidental to such operations for that year of assessment;
- (iii) it is proved to the satisfaction of the Commissioner that the debts in respect of which such deduction is claimed were either:
 - (a) included as a receipt from the carrying on of petroleum operations in the year of assessment in which they were incurred; or
 - (b) advances made in the normal course of petroleum operations not falling within the provisions of section 4(c) of this Law;
- (f) any contribution to a pension or provident fund or other similar fund which is approved by the Commissioner:
 Provided that where the aggregate of the contribution of the employer and employee to any such fund, for any year of assessment exceeds twenty-five per cent of the remuneration paid by the employer to the employee for such year of assessment the aggregate of the deductions to be allowed shall be twenty-five per cent of such remuneration and in every such case the Commissioner shall determine the amounts of the deductions to be allowed to the employer and the employees respectively:

Provided further that where any such fund is first established and a special contribution is made thereto by the employer whereby persons in his employment whose employment commenced prior to the establishment of the fund may qualify for benefits thereunder in respect of such prior employment, the Commissioner may, when approving the fund, authorise such deductions in respect of such special contribution as he may deem fit;
- (g) any sums actually expended by that person in the education or training of citizens and nationals of Ghana in approved educational and technical institutions (including attachment with such person) in any aspects of petroleum operations, or in the provision of scientific and educational materials and equipment pursuant to the terms of a Petroleum Agreement;
- (h) sums representing a special carried interest allowance for that year of assessment including in the event that production from any development and

production area ceases, any amount which would have been recoverable from special carried interest allowance if production from such development and production area to which such allowance relates had not ceased before the sum advanced in respect of Corporation participation had been fully reimbursed;

- (i) such other deductions as may be prescribed by any rule made under the provisions of subsection (4) of this section.
- (2) There shall be deducted in computing the chargeable income of any person carrying on petroleum operations for any year of assessment from and after the year of commencement amounts allowable as capital allowance computed and allocated in the manner set forth in the provisions of the Schedule to this Law.
- (3) There shall be deducted in computing the chargeable income of any person in any year of assessment after the year of commencement the amount of any loss incurred by such person during any previous year of assessment;

Provided that:

- (i) a deduction under this paragraph shall be made so far as possible in computing the amount, if any, of the chargeable income of the first year of assessment after that in which the loss was incurred, and, so far as it cannot be so made, then in computing the chargeable income of the immediately succeeding year of assessment and so on;
- (ii) in no circumstances shall the aggregate deduction in respect of any such loss exceed the amount of such loss;
- (iii) no deduction under the provisions of this paragraph shall be made in respect of any loss incurred prior to the coming into force of this Law.
- (4) The Secretary may by legislative instrument prescribe rules and the method for calculating or estimating the deductions allowed or prescribed under this section.

Section 4—Deductions not Allowed in Ascertaining Chargeable Income.

Subject to the express provisions of this Law, and without prejudice to the deduction of expenses provided for in section 3 of this Law for the purpose of ascertaining the chargeable income arising from petroleum operations of any person no deduction shall be allowed in respect of:

- (a) domestic or private expense;
- (b) any disbursement or expenses not being wholly, exclusively and necessarily laid out or expended for the purpose of petroleum operations;

- (c) any capital withdrawn or any sum employed or intended to be employed as capital;
- (d) any capital employed in improvements;
- (e) any sum recoverable under an insurance policy or contract of indemnity;
- (f) rent of or cost of repairs to any premises or part of premises not paid or incurred for the purposes of petroleum operations;
- (g) any amounts paid or payable in respect of any income tax, profits tax or other similar tax whether charged within Ghana or elsewhere;
- (h) the depreciation of any fixed assets including premises, buildings, structures or works of a permanent nature;
- (i) any contribution to a pension, provident or other similar fund not within the terms of section 3 of this Law.

Section 5—Artificial or Fictitious Transactions

- (1) Where the Commissioner is of the opinion that any transaction which reduces or would reduce the amount of tax payable by any person is artificial or fictitious, he may disregard any such transaction and direct that such adjustments shall be made as regards liability to tax as he considers appropriate so as to prevent the reduction of liability to tax effected, or reduction which would otherwise be effected, by the transaction and the person concerned shall be assessed accordingly.
- (2) For the purpose of this section, the following transactions shall be deemed to be artificial or fictitious:
 - (a) transactions of which the main purpose or one of the main purposes, is, in the opinion of the Commissioner the avoidance or reduction of liability to tax;
 - (b) transactions between persons one of whom, either has control over the other, or in the case of a natural person is related to the other, or transactions between persons both of whom are controlled by some other person which, in the opinion of the Commissioner have not been made on the terms which might fairly have been expected to have been made by independent persons engaged in the same or similar activities dealing with one another at arms length.

PART II—ASCERTAINMENT OF CHARGEABLE TAX

Section 6—Chargeable Tax

The amount of tax payable under this Law (hereafter referred to as "chargeable tax") by any person carrying on petroleum operations in respect of any year of assessment or quarterly period shall be fifty per cent of the chargeable income arising from such operations in respect of the said year or period unless the Petroleum Agreement to which such person is a party makes alternative provision:

- (a) for the payment of income tax at a different rate; or
- (b) for the payment of a tax in lieu of income tax or in lieu of income tax at the rate of fifty per cent otherwise payable hereunder.

PART III—PERSONS ANSWERABLE FOR CHARGEABLE TAX

Section 7—Managers, Partners, Principal Officers

- (1) The manager or any principal officer in Ghana of every company or body of persons shall be answerable for doing all such acts as are required to be done by virtue of this Law for the assessment of tax or provisional tax or both of such company or body and for payment of such taxes.
- (2) In the case of a partnership engaged in petroleum operations, the partner resident in Ghana, or if there be no such partner, the manager, shall be answerable for doing all such acts as are required to be done by virtue of this Law and for the charge to tax of such partnership and for payment of the tax.

Section 8—Commissioners Power to Designate Agents

- (1) Where any person is in possession of, or otherwise liable to pay any sums of money to or is in possession of any assets of a person chargeable to tax under this Law the Commissioner may declare by notice in writing such person an agent in respect of the collection of such tax and such person shall pay any tax due from any assets or moneys including pensions, salaries, wages or any other remuneration in his possession or control.
- (2) For the purpose of this section, the Commissioner may require any person to give him information as to any moneys, funds or other assets which may be held by him, or due by him to any other person.

Section 9—Indemnity

Every person answerable under this Law for the payment of tax or provisional tax or both on behalf of another person may retain out of any money or assets coming into his hands or

within his de facto control on behalf of such other person so much thereof as shall be sufficient to pay such taxes; and shall be and is hereby indemnified against any person whatsoever for all payments made by him in accordance with the provisions of this Law.

PART IV—RETURNS

Section 10—Annual Returns.

- (1) For every year of assessment every person engaged in petroleum operations whether or not chargeable with tax under this Law shall deliver to the Commissioner annual returns covering such year of assessment within four months after the end of such year of assessment.
- (2) Every annual return delivered under subsection (1) of this section shall contain the following statements:
 - (a) a copy of the certified statement of accounts of such petroleum operations for such year of assessment audited before submission by an accountant who shall be a Chartered or Practising Accountant within the meaning of the Chartered Accountants Act, 1963 (Act 170);
 - (b) an estimate of the tax due on the chargeable income computed;
 - (c) a statement containing the full names, addresses, nationality, salaries, wages, fees, allowances and other remuneration of his employees in Ghana;
 - (d) a statement of the amount of production of petroleum during such year of assessment and the share of such person in that production; and
 - (e) a statement of the price paid for the sale or export without sale of that person's share of petroleum produced in that year of assessment in accordance with section 2 of this Law.
- (3) Annual returns delivered under subsection (1) of this section shall be accompanied by a signed declaration that the particulars given in the annual returns or component statements are true and complete.
- (4) Every person chargeable with tax under this Law shall deliver along with his annual returns a remittance in settlement of his tax liability as computed in his returns.
- (5) Where there is a dispute as to the World Market Price applicable in respect of such person's share of petroleum produced for any period in such year of assessment a return indicating the amount of chargeable income shall be computed by such person on the basis of the contractor's proposed price:

Provided that in the event of final determination of the price in accordance with the terms of a petroleum agreement there shall pursuant to this section be submitted fresh returns reflecting the determined price and any adjustments and payments of

tax due in respect thereof. Such returns shall be submitted within forty-five days of the final determination of the price.

Section 11—Quarterly Returns

- (1) Every person engaged in petroleum operations shall, not later than thirty days after the expiry of any quarterly period, furnish or deliver to the Commissioner:
 - (a) a return containing an estimate of the chargeable income resulting from the operations during that quarterly period; and
 - (b) an estimate of tax due on the chargeable income computed and a remittance in settlement of the tax so computed.
- (2) For the purpose of subsection (1) of this section the Commissioner may from time to time issue to any person engaged in petroleum operations a supply of quarterly return forms and such person shall use any such forms so supplied in furnishing returns pursuant to that subsection.

Section 12—Extension of Time and Provisional Returns

- (1) Where it is shown by any person to the satisfaction of the Commissioner that owing to some reasonable cause that person is not able to make a return required by the provisions of section 10(1), 11(1) or 14 of this Law within the time specified in such sections the Commissioner may grant such extension of the time specified as he may consider necessary.
- (2) where under subsection (1) of this section an extension of the time specified in subsection (1) of section 11 is granted by the Commissioner the person to whom such extension is granted shall within fourteen days of the granting of such extension furnish a return based on an estimate of the chargeable income resulting from the petroleum income resulting from the petroleum operations in respect of which the return is required to the best of his knowledge and belief.

Section 13—Power to Call for Further Information

The Commissioner may give notice in writing to any person engaged in petroleum operations when and as often as he thinks necessary requiring him to furnish within the time limited by such notice fuller or further information as to any matters either referred to in section 10 of this Law or to any matters which the Commissioner may consider necessary for the purpose of this Law.

Section 14—Additional Returns

- (1) After an annual or quarterly return has been furnished in respect of any year of assessment or quarterly period respectively the Commissioner may for the purpose of obtaining full information in respect of any person's chargeable income give notice

to such person requiring him within the time limited by such notice, which time shall not be less than thirty days from the date of service of such notice, to complete and deliver to the Commissioner any additional return specified in such notice and in addition or alternatively requiring him to attend before him and to produce for examination any books, documents, accounts and returns which the Commissioner may deem necessary.

- (2) If a person assessable to tax under the provisions of this Law fails or refuses to keep books or accounts which, in the opinion of the Commissioner, are adequate for the purposes of ascertaining the chargeable tax, the Commissioner may by notice in writing require him to keep such records, books and accounts as the Commissioner considers to be adequate in such form and in such language as he may in the said notice direct and, the person shall keep records, books and accounts as directed.

Section 15—Power to Enter Premises

- (1) The Commissioner or his duly authorised agent may for the purpose of obtaining information which he considers necessary in relation to the liability of any person to tax, enter any premises in Ghana at any time during the day, without previous notice and search for any moneys, assets, documents or records and in carrying out any such search he may:
 - (a) open or cause to be removed and opened, any article in which he considers any moneys, assets, documents or records may be contained;
 - (b) seize any money or assets and any documents or records which he considers may afford material evidence of the liability of any person to tax;
 - (c) retain such moneys or assets and any such documents or records or any copies thereof for such periods as may be reasonable for their examination or for the purposes of a prosecution or the recovery of the tax due.
- (2) The Commissioner or such duly authorised agent conducting the search shall:
 - (a) make an inventory of and issue receipts for any moneys, assets, documents or records seized;
 - (b) make copies of any such documents or records and provide copies to the person from whose custody they were obtained.
- (3) Any person who prevents the Commissioner or his duly authorised agent from exercising his powers under subsection (1) of this section shall be guilty of an offence and liable on summary conviction to a fine of not less than ₵50,000.00 or to imprisonment with hard labour for a term of not less than two years.
- (4) For the purpose of this section any person who without reasonable cause or excuse destroys or conceals any relevant document shall be guilty of an offence and liable

on summary conviction to the fine or imprisonment specified in subsection (3) of this section.

PART V—ASSESSMENT

Section 16—Assessments

(1) Subject to subsection (2) of this section, the Commissioner shall assess every person chargeable with tax for any year of assessment or with provisional tax for any quarterly period as soon as may be after:

- (a) receipt of returns filed by such person; or
- (b) the expiry of the periods (including extensions) for submission of such returns provided for in this Law:

Provided that where returns are made under section 12(2) of this Law the Commissioner shall pursuant to section 14(1) of this Law call for additional returns from such person before making a final assessment.

(2) Where a person has delivered a statement or return the Commissioner may —

- (a) accept the statement or return and make an assessment accordingly; or
- (b) refuse to accept the statement or return if he is reasonably satisfied that such return or statement does not represent a true and accurate statement of the liability to tax of such person and proceed as provided in subsection (3) of this section upon a failure to deliver a statement or return and the like consequences shall ensue.

(3) Where a person has not delivered a statement or return:

- (a) within the time specified under the provisions of sections 10, 11, or 14 of this Law;
- (b) within any extended time under the provisions of section 12(1) of this Law; or

(c) within the fourteen days specified in section 12(2) of this Law, as the case may be and the Commissioner is of opinion that such person is liable to pay tax or provisional tax, as the case may be, he may estimate, according to the best of his judgment, the amount of the chargeable tax to be paid by such person for the year of assessment or the quarterly period respectively for which any such statement or return is required, and make an assessment accordingly. Such assessment shall not affect any liability otherwise incurred by such person by reason of his failure or neglect to deliver a statement or return:

Provided that nothing in this subsection shall affect the right of the Commissioner to make any additional assessment under the provisions of section 17 of this Law or to certify any repayment under the provisions of section 25 of this Law if upon ascertainment of the

relevant facts it appears to the Commissioner that any such additional assessment or repayment, as the case may be should be made.

Section 17—Additional Assessment

- (1) If the Commissioner discovers or is of opinion at any time that any person liable to tax or provisional tax has not been assessed or has ben assessed at an amount different from what he ought to have been assessed at, the Commissioner may assess such person as often as may be necessary at such amount or additional amount as, according to his judgment, ought to have been charged.
- (2) In the event of a final determination of World Market Price under section 10(5) the Commissioner shall make a new or additional assessment as may be requisite to give effect thereto.

Section 18—Record and Notice of Assessment

- (1) The Commissioner shall, upon assessing the tax or provisional tax payable by any person, enter the name and address of the person assessed, and the amount of the assessment and chargeable tax in an assessment record.
- (2) The Commissioner shall in respect of each assessment cause to be served upon each person assessed a notice of assessment stating the amount of chargeable income liable to tax or to provisional tax charged, the place at which, and the time by which payment of any outstanding amount of such tax or provisional tax should be made and informing him of his rights of appeal under the provisions of sections 19, 20 and 21 of this Law:

Provided that no assessment under section 16 of this Law nor any additional assessment under section 17 of this Law shall be made later than 4 years from the end of the year of assessment or quarterly period to which such assessment or additional assessment relates.

PART VI—OBJECTIONS AND APPEALS

Section 19—Objections and Review

- (1) If any person disputes an assessment made upon him in accordance with the provisions of this Law he may apply to the Commissioner to review and revise such assessment. Such application shall be by written notice stating the precise grounds of objection, and shall be made within thirty days from the date of service of the notice of such assessment and shall state the amount of chargeable income made by such person during the year of assessment and the amount of tax which he claims should be charged:

Provided that the Commissioner upon being satisfied that owing to absence from Ghana, sickness or other reasonable cause, the person disputing the assessment was prevented from making the application within such period, shall extend the period as may be reasonable in the circumstances.

- (2) After receipt of a notice of objection referred to in subsection (1) of this section the Commissioner may within such time and at such place as he shall specify, require the person giving the notice of objection to furnish such particulars as the Commissioner may deem necessary and may by notice, within such time and at such place as he shall specify, require any person to give evidence orally or in writing respecting any matters necessary for the ascertainment of the tax or provisional tax payable, and the Commissioner may require such evidence if given orally to be given on oath or if given in writing to be given by statutory declaration.
- (3) In the event of any person, who has objected to an assessment made upon him, agreeing with the Commissioner as to the amount for which he is liable to be assessed, the assessment shall be amended accordingly, and notice of the tax or provisional tax under the amended assessment shall be served upon such person.
- (4) If any person, who has objected to an assessment made upon him, fails to agree with the Commissioner in the manner provided in subsection (3) of this section, the Commissioner shall give him notice of refusal to amend his assessment as desired by such person or may amend such assessment if he is satisfied that the assessment is in any event excessive by some amount by reducing it by such amount, and notice of the amended assessment showing the tax or provisional tax payable thereunder shall be served upon such person together with the notice of refusal.

Section 20—Appeals to the Office of the Revenue Commissioners

- (1) Any person who, is aggrieved by a notice of refusal, or is dissatisfied with an assessment whether amended, under the provisions of section 19(4) of this Law, or not, may appeal to the Revenue Commissioners against such an assessment or amended assessment upon giving notice in writing to the Commissioner within thirty days after the date of service upon him by the Commissioner of notice of refusal to amend the assessment under the provisions of section 19(4) of this Law:

Provided that notwithstanding the lapse of such period of thirty days, any person may bring an application against an assessment or amended assessment if he shows to the satisfaction of the Revenue Commissioners that, owing to absence from Ghana, sickness or other reasonable cause he was prevented from giving notice of such application within such period, and that there has been no unreasonable delay on his part.

- (2) The onus of proving that the assessment complained of is excessive shall be on the appellant.

- (3) The Revenue Commissioners may confirm, reduce, increase, or annul the assessment or make such order thereon as it may deem fit.
- (4) Notice of the amount of tax payable under the assessment as determined by the Revenue Commissioners shall be served by the Commissioner either personally, or by registered post, on the appellant.

Section 21 – Appeals to the Supreme Court

An appeal against the decision of Revenue Commissioners on both questions of law and fact shall lie to the Supreme Court.

Section 22 – Assessment Final and Conclusive

- (1) Except as expressly provided in this Law;
 - (a) where no objection has been lodged against any assessment under the provisions of section 19(1) of this Law; or
 - (b) where the amount to be assessed has been agreed to under the provisions of section 19(3) of this Law; or
 - (c) where after the determination of an objection made under the provisions of section 19(4) of this Law, whether the assessment was reduced or otherwise, no appeal to the Revenue Commissioners has been made under the provisions of section 20 of this Law; or
 - (d) where such appeal has been determined by the Revenue Commissioners and no further appeal taken; or
 - (e) where such amount has been determined on appeal; the assessment as made, or agreed to, or reduced, or determined, as the case may be shall be final and conclusive for all the purposes of this Law as regards the amount of such assessment.
- (2) Where any application to the Revenue Commissioners has been brought against an assessment and then withdrawn such assessment as made or reduced by the Commissioner shall be final and conclusive for all purposes of this Law.
- (3) Nothing in this Part of this Law shall prevent the Commissioner from making any assessment or additional assessment for any year of assessment which does not involve re-opening any matter, relating to that period, which has been determined on appeal by the Revenue Commissioners or the Supreme Court.

PART VII—COLLECTION, RECOVERY AND REPAYMENT OF TAX

Section 23—Commissioners to Make Determination Where Objection Pending

- (1) Where notice of objection has been given under the provisions of section 19 of this Law, the Commissioner shall decide what tax shall be paid pending the determination of the objection.
- (2) The amount of tax to be paid by any person under this section shall not be less than fifty per cent of the tax specified in the appropriate notice of assessment and shall be paid within such time as the Commissioner may specify by written notice:

Provided that where payment of any tax has been held over pending the result of an objection, the tax outstanding under the assessment as determined in such objection shall be payable within thirty days after the date of service on the person assessed of the notification of the tax payable.

Section 24—Time Within Which Payment is to be Made

- (1) Tax or provisional tax assessed in accordance with section 16 of this Law shall subject to section 23 be payable at the place stated in the notice of assessment, given under the provisions of section 18(2) of this Law, within thirty days after the service of such notice.
- (2) The Commissioner may where good cause is shown extend the period within which such tax or provisional tax shall be paid under the provisions of subsection (1) of this section to such period as he may deem fit.

Section 25—Suit for Recovery of Tax

- (1) Subject to the provisions of sections 19, 20 and 21 of this Law, tax or provisional tax may be sued for and recovered in any court of competent jurisdiction by the Commissioner in his official name with full costs of suit from the person charged therewith as a debt due to the Government of Ghana:
Provided that any suit for tax payable and recoverable under this Law shall not be commenced later than 12 years from the date such tax is due.
- (2) In any suit under subsection (1) of this section the production of an extract from the assessment record verified under the hand of the Commissioner giving the name and address of the defendant and the amount of tax due by him shall be sufficient evidence of the amount so due and sufficient authority for the Court to give judgment for the said amount.

Section 26—Repayment of Tax

- (1) If it is proved to the satisfaction of the Commissioner that any person has paid any tax in excess of the amount for which he is liable under a final and conclusive

determination such person shall be entitled to have the amount so paid in excess refunded.

- (2) Every claim for repayment under this section shall be made within six years from the final and conclusive determination of the amount of tax due in respect of the year of assessment to which such claim relates.
- (3) The Commissioner shall give a certificate of the amount to be repaid and the repayment shall be effected in accordance therewith.

PART VIII—SUB-CONTRACTORS AND EXPATRIATE EMPLOYEES

Section 27—Withholding Tax on Amounts Due to Sub-Contractors

- (1) Where under the terms of a contract any amount due to a sub-contractor in respect of work or services for or in connection with a Petroleum Agreement the person liable under that contract to make payment to the sub-contractor shall withhold from the aggregate amount due as may be specified in the Petroleum Agreement and the amount so withheld shall be paid to the Commissioner and payment thereof shall have the effect provided for in subsection (2) of this section:

Provided that this requirement may be waived by the express terms of the Petroleum Agreement where the sub-contractor is an affiliate of the contractor whose services are charged to the contractor at cost.

- (2) When an amount has been withheld from an aggregate amount due to a sub-contractor pursuant to subsection (1) of this section the sub-contractor shall not in respect of that aggregate amount be liable for tax under the provisions of any other law in force in Ghana.
- (3) Nothing in section 55(7) of the Income Tax Decree, 1975 (SMCD 5) shall apply to a contract for the supply of goods or the provision of work or services for or in connection with petroleum operations.
- (4) Nothing in section 2(1) of the Income Tax Decree, 1975 (SMCD 5) shall apply to the calculation of the gains and profits of a person who is a non-resident sub-contractor by reason only of the provision by such non-resident sub-contractor of work or services for or in connection with a Petroleum Agreement.

Section 28—Expatriate Employee

Unless, and to the extent that, a Petroleum Agreement provides in respect of any expatriate employee employed by a contractor or a sub-contractor carrying on exclusively petroleum operations the gains or profits of such employee shall be liable to income tax and the withholding of tax under the laws of Ghana.

PART IX – ADMINISTRATION

Section 29 – Administrative Authority

- (1) This Law shall be administered by the Commissioner, who shall be responsible for the assessment and collection of the tax chargeable under the provisions of this Law and the payment of such tax into the account of the Internal Revenue Service designated for such purposes.
- (2) The Commissioner may in writing, or by notice in the Gazette, authorise any person to perform, or to assist in the performance of, any duty imposed upon the Commissioner by this Law.
- (3) Every person having any official duty in the administration of this Law, or being employed for the purpose of the administration of this Law or being authorised under the provisions of this section shall act in accordance with the lawful instructions of the Commissioner.

Section 30 – Obligations of Secrecy

- (1) Every person having any official duty in the administration of this Law, and having possession of, or control over any documents, accounts or information relating to petroleum operations and the amount and value of petroleum produced and saved by any person who at any time communicates such information or anything contained in such documents or accounts to any person, other than a person to whom he is authorised by law to communicate it to, for the purpose of this Law or the Income Tax Decree, 1975 (SMCD 5), shall be guilty of an offence, and liable on summary conviction to a fine not exceeding ₪50,000.00 or to imprisonment for a term not exceeding six months or to both such fine and imprisonment.
- (2) Any proceedings for an offence against this section may be taken by the Commissioner but not by any other person except with the consent of the Attorney-General.
- (3) The obligations as to secrecy imposed by the provisions of this Law shall not prevent the disclosure to any person, authorised under the provisions of section 29 of this Law, to administer or to assist in the administration of this Law, of such facts as are necessary to enable the proper tax imposed by this Law to be assessed or collected.
- (4) Any person who by reason of the provisions of this Law has possession of or control over any documents, accounts or information relating to petroleum operations and the amount and value of petroleum produced and saved by any person shall, for the purpose of subsection (1), be deemed to have an official duty in the administration of this Law.

Section 31 – Service of Notice

- (1) A notice may be served on a person:

- (a) personally; or
 - (b) by being left at his usual or last known place of abode; or
 - (c) by being sent through registered post, addressed to such person at his usual or last known business or private address including any post office box number or private post bag; or
 - (d) in the case of a company incorporated or registered in Ghana addressed to the manager of the company, or any principal officer thereof in Ghana at the registered office of the company or at the principal place of business in Ghana of such company; or
 - (e) in the case of a partnership by being sent through the post to the usual or last known business or private address of a partner resident in Ghana or if there is no such partner, to the usual or last known business or private address of the Manager of the partnership business addressed to such partner or Manager; or
 - (f) in the case of a body of persons, addressed to such body at the last known business or other address of such body.
- (2) All notices under this Law to be served by post shall be sent by registered post and shall be deemed to have been served on the day succeeding the day on which the addressee of the registered letter containing the notice would have been informed in the ordinary course that such letter is awaiting him.
- (3) Every notice to be given by the Commissioner under this Law shall be signed by the Commissioner or by such person as may from time to time be authorised by him for that purpose under the provisions of section 29(2) of this Law and every notice shall be valid if the signature of the Commissioner or of such person is duly printed or written thereon.

PART X – OFFENCES AND PENALTIES

Section 32—Failure to Comply with Notice or Summons

Any person who without reasonable excuse fails to comply with the requirements of a notice or summons served upon him under and in accordance with the provisions of this Law, within the time prescribed, shall be guilty of an offence, and shall be liable on summary conviction to a fine of not less than ₵100,000.00 or to imprisonment for a term not exceeding one year or to both such fine and imprisonment and, in the case of failure to comply with a notice requiring tax or provisional tax to be paid, shall in addition incur a penalty of a sum equal to fifteen per cent of the tax payable.

Section 33—Failure to make Returns and Falsification of Returns

- (1) Any person who without reasonable excuse:
- (a) fails to make a return or statement in accordance with the provisions of this Law; or
 - (b) makes an incorrect return or statement which he is required by this Law to make; or
 - (c) gives any incorrect information in relation to any matter or thing affecting his own liability, or the liability of any other person, to tax or provisional tax; shall be guilty of an offence and, shall be liable on summary conviction to pay a penalty double the amount of tax, or provisional tax which has been undercharged in consequence of such incorrect return, statement or information, or which would have been so undercharged if the return, statement or information had been accepted as correct or which would have been charged if the return which should have been made, had been made.
- (2) Where such person is a body corporate then every director and officer of that body shall be deemed guilty of the offence and on summary conviction shall be liable to the penalty provided for in subsection (1) of this section:

Provided that no such director or officer shall be held guilty of the offence if he proves that such offence was committed without his knowledge or that he exercised due diligence to prevent the commission of the offence:

Provided further that no person shall be liable to the penalty provided under the provisions of this section unless proceedings for the recovery of the penalty were commenced within six years after the act or omission to which the penalty relates.

Section 34—Misrepresentation to Obtain Tax Reduction

- (1) Any person, who for the purpose of obtaining any reduction in tax, or provisional tax, for himself or any other person knowingly and wilfully misrepresents any fact relevant to the ascertainment of such tax shall be guilty of an offence and shall be liable on summary conviction to a fine not exceeding ten million cedis or to imprisonment for a term not exceeding four years or to both such fine and imprisonment.
- (2) Where such person is a body corporate then every director and officer of that body shall be deemed guilty of the offence and liable to the penalty provided for in subsection (1) of this section:
- Provided that no such director or officer shall be deemed to be guilty of the offence, if he proves that such offence was committed without his knowledge or that he exercised due diligence to prevent the commission of the offence.

Section 35—Recovery of Penalties

- (1) Pecuniary penalties, not being fines, incurred under the provisions of sections 32 and 33 of this Law may be sued for, enforced and recovered with full cost of suit in civil proceedings before the High Court.
- (2) Proceedings for the recovery of any pecuniary penalty incurred under the provisions of section 32 and 33 of this Law shall not relieve any person from liability to criminal proceedings in respect of the commission of any offence against the provisions of this Law.
- (3) Penalties under the provisions of this Law received by the Commissioner shall be paid into the account of the Income Tax Authority designated for such purposes.

Section 36—Tax to be Payable Notwithstanding Any Proceedings for Penalties or Offences

The institution of proceedings against offenders under this Law shall not relieve any persons from their liability to pay any tax or provisional tax for which he is or may become liable.

PART XI—MISCELLANEOUS

Section 37—Power to make Regulations and Prescribe Forms

- (1) The Secretary may make regulations generally for the better carrying out of the provisions of this Law.
- (2) The Commissioner may from time to time specify the form of returns, claims, statements, notices and applications to be made or given under this Law.

Section 38—Interpretation

- (1) A word and phrase to which a meaning has been attributed in the Petroleum (Exploration and Production) Law, 1984 (PNDCL 84) shall unless the context otherwise requires be given the same meaning when used in this Law.
- (2) In this Law unless the context otherwise requires:
 - "affiliate" means any company which holds not less than five per cent of the share capital or voting rights in a company carrying on petroleum operations and shall include any company which controls, is controlled by, or is under common control with, any person carrying on petroleum operations;
 - "carried interest" means an interest held by the Corporation in respect of which a contractor advances sums for the conduct of petroleum operations pursuant to the express terms of a Petroleum Agreement;
 - "chargeable income" means income ascertained as chargeable with tax for any year of assessment in accordance with this Law;
 - "Commissioner" has the same meaning as in the Income Tax Decree, 1975 (SMCD 5);

"company" means any person, firm, body corporate, registered or incorporated in Ghana under the provisions of the Companies Code, 1963 (Act 179);

"corporation" means the Ghana National Petroleum Corporation established by the Ghana National Petroleum Corporation Law, 1985 (PNDCL 64);

"contractor" means any person which is a party to a Petroleum Agreement with the Republic and the Corporation made pursuant to section 5(4) of the Petroleum (Exploration and Production) Law, 1984 (PNDCL 84);

"expatriate employee" means a person who is not a citizen of Ghana and who is employed for or in connection with the conduct of petroleum operations by a contractor or by a sub-contractor under an express or implied contract of employment which provides for payment of passages to and from Ghana and in respect of whom approval has been obtained from the Government of Ghana for his inclusion within the immigrant quota of such employer;

"first quarterly period" means the quarterly period within which a person commences petroleum operations under the terms of a Petroleum Agreement;

"Ghana" means the territory of the Republic of Ghana and includes the sea, seabed, subsoil, the continental shelf and all other areas within the jurisdiction of the Republic of Ghana;

"gross income" means in the case of a person carrying on petroleum operations, the income derived by such person from the sale or export without sale of all petroleum to which that person is entitled under a Petroleum Agreement and income incidental thereto before making of the deductions for which provision is made in this Law for the purpose of calculating chargeable income:

Provided however that gross income does not include —

- (a) any of the amounts referred to in Paragraph 5 of the Schedule; or
- (b) consideration for an assignment falling under Paragraph 7 of the Schedule;

"loss" means in relation to any year of assessment from and after the year of commencement, the amount by which deductions allowable under section 3 of this Law exceeds gross income;

"person" has the same meaning as in J

"petroleum capital expenditure" means expenditure incurred in searching for and discovering petroleum, ascertaining and testing the extent and characteristics thereof, and the installation of facilities for the production, gathering, transportation and sale or export or both of petroleum and includes:

- (i) sums expended in the acquisition of an interest or a participating interest in a Petroleum Agreement but not including any such expenditure incurred after the year of commencement in or on an acquisition from a person who is carrying on production of petroleum under a programme of continuous production and sale; and
- (ii) expenditure including, where applicable, intangible costs incurred on:

- (a) geological, geophysical, geochemical, aerial, magnetic, gravity, seismic and other surveys and all processing, analyses, interpretations and studies related thereto;
- (b) drilling of shot holes, core holes, bore holes, water holes and holes for the discovery and delineation of petroleum reservoirs;
- (c) preparing for drilling, drilling, and maintaining exploration, appraisal, development and production wells whether such wells are producing or not, including all costs of labour, fuel, repairs, haulage and supplies, and materials without salvage value, incurred in:
 - (i) drilling, shooting and cleaning wells;
 - (ii) clearing and draining ground, road making, surveying and other preparations for drilling;
 - (iii) constructing and erecting drilling rigs, drilling and production platforms, tanks, pipelines;
- (d) acquisition of petroleum information and the costs of all reservoir studies;
- (e) the provision of plant, machinery and equipment including construction and erection of drilling rigs, drilling and production platforms and other plant, machinery, and equipment necessary for the exploration for, and the development and production of petroleum;
- (f) the construction of any building, structures or works including the provision of residential accommodation and associated facilities for employees;
- (g) the provision of any transportation or communication facilities required for the conduct of petroleum operations;
- (h) the provision of office equipment and furniture;
- (i) the preparation of sites for production, including engineering and design studies, delineation work and feasibility studies done to determine the best means of operation;
- (j) any sums payable by way of reimbursement of costs and premium thereon to any party for the conduct of sole risk operations pursuant to the terms of a Petroleum Agreement;
- (iii) expenditure incurred prior to the year of commencement in or on:
 - (a) general administration and management directly connected with petroleum operations;

- (b) subject to the limitation set forth in the proviso to section 3(1)(c) any interest paid in respect of any loan for the time being utilised to finance petroleum operations;
 - (c) the education and training of citizens or nationals of Ghana at approved educational or technical institutions and including attachment with a contractor in any aspect of petroleum operations, and the provision of educational and scientific materials and equipment pursuant to the terms of a Petroleum Agreement;
 - (d) rentals; and
 - (e) any other such expenditure which if incurred in or after the year of commencement would be deductible under section 3;
- (iv) where applicable, expenditures incurred by a contractor on behalf of the Corporation in respect of a carried interest within the meaning and pursuant to the terms of a Petroleum Agreement to the extent that the same have not been included within any other category of expenditure referred to in this definition of petroleum capital expenditure.
- "petroleum information" means geological, geophysical and technical information, being information that relates to the presence, absence or extent of deposits of petroleum in an area, or is likely to be of assistance in determining the presence, absence or extent of such deposits;
- "petroleum operations" means exploration, development or production operations including operations for the sale, or export without sale of petroleum, being operations carried by a contractor;
- "quarterly period" means the period from 1st January to 31st March, 1st April to 30th June, 1st July to 30th September or 1st October to 31st December;
- "rentals" means sums payable as rental charges in respect of the surface area to which a Petroleum Agreement relates and which, in accordance with section 18 of the Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), have been prescribed or, as the case may be, are otherwise provided for under the terms of a Petroleum Agreement;
- "resident in Ghana" has the same meaning as in section 76 of the Income Tax Decree, 1975 (SMCD 5);
- "Revenue Commissioners" shall have the same meaning as in the Revenue Commissioners Law, 1985 (PNDCL 80);
- "royalties" means royalties payable to the Republic by a contractor out of, or calculated by reference to, petroleum to which such contractor is entitled under the terms and conditions of a Petroleum Agreement;
- "Secretary" means the PNDC Secretary responsible for Revenue;
- "special carried interest allowance" means the gross income derived from the sale or export without sale of petroleum transferred to a contractor from what would otherwise be the entitlement of the Corporation where a Petroleum Agreement has provided for the advance of sums to the Corporation by a

Contractor in respect of the Corporation's participating interest and for the reimbursement of such advances from the Corporation's entitlement to production;

"sub-contractor" means any person who enters into a contract with a contractor for the provision of work or services (including rental of plant and equipment) in Ghana for or in connection with the Petroleum Agreement to which such contractor is a party and where a Petroleum Agreement so provides includes any "non-resident person" or "non-resident company" (as those terms are defined in the Income Tax Decree, 1975 (SMCD 5) who under the terms of a contract provides such work or services;

"year of assessment" has the same meaning as in the Income Tax Decree, 1975 (SMCD 5);

"year of commencement" means in relation to any Petroleum Agreement the year of assessment in which the contractor first produces petroleum under a programme of continuous production for sale.

Section 39—Repeal and Disapplication of Other Tax Legislation

- (1) Petroleum Income Tax Law, 1986 (PNDCL 185) is hereby repealed.
- (2) The provisions contained in the Third Schedule to the Income Tax Decree, 1975 (SMCD 5) shall not apply to petroleum operations.
- (3) There shall be no tax charged, or withholding of tax required, under the provisions of the Income Tax Decree, 1975 (SMCD 5) in respect of any income, or dividends paid out of any income which is taken into account in ascertaining chargeable income or loss under the provisions of this Law, or which is excluded from gross income hereunder.
- (4) Nothing in the Additional Profits Tax Law, 1985 (PNDCL 122) or the Capital Gains Tax Decree, 1975 (NRCD 347) shall apply to petroleum operations hereunder.
- (5) Except as specifically provided in this Law or under legislative instruments made under section 41, the general laws of Ghana relating to tax administration, jurisdiction to impose tax and to try offences in respect of tax matters, shall continue to apply to the matters provided for in this Law.

Section 40—Penalties and Fines to be Paid in Currency in which Tax is Payable

All penalties and fines provided for in this Law shall be paid in the currency in which payments of tax are to be made under the terms of the applicable Petroleum Agreement.

Section 41—Exemption

Where he deems fit the Secretary may by legislative instrument exempt a contractor from the operation of any general law or provisions thereof relating to taxation other than this Law.

SCHEDULE

(Section 3)

CAPITAL ALLOWANCES

ARRANGEMENT OF PARAGRAPHS

Paragraph

1. Capital allowances to be deducted in ascertaining chargeable income.
2. Capital allowance for the year of commencement
3. Annual capital allowance
4. Calculation of annual deductions
5. Netting of expenditures for capital allowance for year of commencement
6. Sale of assets after year of commencement
7. Assignment of interest after year of commencement
8. Exclusion of other capital chargeable
9. Apportionment
10. Part of an asset

Paragraph 1—Capital Allowances to be Deducted in Ascertaining Chargeable Income

In ascertaining for any year of assessment the chargeable income of any person carrying on petroleum operations there shall be deducted from his gross income in the year of commencement and in subsequent years of assessment capital allowances calculated as hereinafter provided.

Paragraph 2—Capital Allowance for the Year of Commencement

- (1) The capital allowance for the year of commencement (hereinafter referred to as the capital allowance for the year of commencement) shall be calculated by dividing the amount which is the sum of petroleum capital expenditure incurred by a person carrying on petroleum operations in the year of commencement and the petroleum capital expenditure incurred in previous years by five and the amount so calculated shall be deducted in the year of commencement and in each of the immediately succeeding four years.
- (2) The capital allowance for the year of commencement shall cease to subsist where it has been deducted in five successive years including the year of commencement.

Paragraph 3—Annual Capital Allowance

- (1) For any year of assessment after the year of commencement, an annual capital allowance shall be calculated by dividing the total petroleum capital expenditure

incurred in that year by five and the amount so calculated shall be deducted in that year and in each of immediately succeeding four years.

- (2) An annual capital allowance shall cease to subsist where it has been deducted in five successive years including the year in respect of which it was first calculated.

Paragraph 4—Calculations of Annual Deductions After Year of Commencement

The capital allowance for any year of assessment after the year of commencement shall be the sum of:

- (i) the annual capital allowance for that year; and
- (ii) the sum of the amounts required to be deducted in that year pursuant to —
 - (a) sub-paragraph (1) of paragraph 2 in respect of the capital allowance for the year of commencement for so long as that allowance subsists; and
 - (b) sub-paragraph (1) of paragraph 3 in respect of subsisting annual capital allowances for previous years.

Paragraph 5—Netting of Expenditures for Capital Allowance for Year of Commencement

For the purpose of calculating the capital allowance for the year of commencement pursuant to paragraph 4(ii)(a) petroleum capital expenditure incurred in the year of commencement and in previous years shall be net expenditure after deducting:

- (a) as consideration in respect of the acquisition by any other person of an interest or proportionate part thereof in a petroleum agreement and in the assets held in connection therewith in respect of which petroleum capital expenditure has been incurred;
- (b) in the case of the sale of an asset in respect of which petroleum capital expenditure has been incurred not being a sale falling under paragraph (a) the proceeds of sale;
- (c) in the case of loss or destruction of any such asset, any insurance moneys, compensation as damages paid in respect thereof;
- (d) any sums received by a person carrying on petroleum operations as reimbursement of costs and premium thereon in respect of sole risk operations conducted pursuant to the terms of a Petroleum Agreement; and
- (e) any other amount received in respect of, or in connection with petroleum operations in or before the year of commencement.

Paragraph 6— Sale of Assets After Year of Commencement

- (1) If in any year after the year of commencement any asset in respect of which petroleum capital expenditure has been incurred, is sold by a person carrying on petroleum operations, or is lost, or destroyed, the proceeds of such sale, or in the case of an asset lost or destroyed any insurance moneys, compensation or damages received by such person shall be divided by five and the resulting amount shall in that year and in each of the immediately succeeding four years be added to the gross income of such person from petroleum operations for the purpose of calculating his chargeable income.
- (2) Any sums received after the year of commencement as reimbursement of cost and premium to a sole risk party under the sole risk terms of a joint operating agreement shall be treated as proceeds from the sale of an asset and shall be divided by five and the resulting amount shall in that year and in each of the immediately succeeding four years be added to the gross income of such person from petroleum operations for the purpose of calculating his chargeable income.
- (3) Nothing in this paragraph shall apply to the assignment of an interest in a Petroleum Agreement or any proportionate part thereof or to any other asset assigned therewith.

Paragraph 7— Assignment of Interest After the Year of Commencement

Where in any year of assessment after the year of commencement, a person carrying on petroleum operations has assigned his interest in a Petroleum Agreement or a proportionate part thereof and his interest in assets held in connection therewith or a proportionate part thereof —

- (a) the capital allowances to which the assignor would otherwise have been entitled in respect of petroleum capital expenditure and incurred before the assignment will be reduced for that year and subsequent years for as long as such allowances subsist by a proportion corresponding to the proportion of the interest of the assignor in the Petroleum Agreement which has been so assigned;
- (b) the capital allowances to which the assignee would otherwise have been entitled in respect of petroleum capital expenditure incurred by the assignee in that year and subsequent years will be increased by an amount equal to the amount by which the capital allowances of the assignor for that year and any subsequent year has been reduced, pursuant to subparagraph (a).

Paragraph 8—Exclusion of Other Capital Chargeable

Where a deduction is made under this Schedule in respect of any petroleum capital expenditure in computing the income of a person carrying on petroleum operations in respect of any year of assessment, then to the extent to which such a deduction has been made, no further deduction shall be made under any other provision of this Law in respect of the same petroleum capital expenditure in ascertaining the chargeable income of such person in respect of the same or any previous or subsequent year of assessment.

Paragraph 9—Apportionment

Any reference in this Schedule to the sale of any asset includes a reference to the sale of that asset, together with any other asset, whether or not petroleum capital expenditure has been incurred on such last-mentioned asset: and, where an asset is sold, together with another asset, so much of the value of the asset as, on a just apportionment, is properly attributable to the first mentioned asset shall, for the purposes of this Schedule, be deemed to be the price paid for that asset.

Paragraph 10—Part of an Asset

Any reference in this Schedule to any asset shall be construed whenever necessary as including a reference to a part of any asset (including an undivided part of that asset in the case of joint interest therein) and when so construed any necessary apportionment shall be made as may, in the opinion of the Commissioner, be just and reasonable.

Made this 20th day of May 1987.

FLT.-LT. JERRY JOHN RAWLINGS

Chairman of the Provisional National Defence Council

Date of Gazette Notification: 4th September, 1987.

APPENDIX 4

How Petroleum is Formed, Produced and Transported

(Brief by E. A. QUAYE-FOLI, Ministry of Energy)*

Petroleum hydrocarbons made up of crude oil, natural gas and natural gas liquids are generally found in tiny gaps in sedimentary rocks formed hundreds of millions of years ago.

The hydrocarbons are typically in porous formation under an impermeable layer of rock that prevents them from dispersing and moving towards the surface.

TYPES OF ROCKS

Rocks forming the earth's crust are traditionally divided into three groups according to their origin:-

- Igneous
- Sedimentary
- Metamorphic.

Igneous rocks were formed as a result of the cooling and solidifying of molten magma erupted from the earth's interior. Rocks of this type are thought to make up about 95% of the outermost crust of the earth. They are generally hard, crystalline in structure, and are practically devoid of pore space, or voids.

Sedimentary rocks are made up of sediments that are deposited on the surface of the ground or the bottoms of oceans, then cemented and compacted into hard rocks. These then form the source and reservoir rocks for oil and gas.

Metamorphic rocks are formed as a result of processes which occur in a high-pressure and high-temperature environment that change the composition and structure of original igneous and sedimentary rocks.

They do not contain fossils and resemble igneous rocks in their crystalline-grain structure and sedimentary rocks in the parallel-linear distribution of mineral grains.

It is important to note that commercial crude oil and gas reserves are found mainly in sedimentary rocks. In igneous and metamorphic rocks oil and gas rarely occur and, as a rule, have no commercial significance.

SOURCES OF PETROLEUM

There are two sources of petroleum, namely SOURCE ROCK and RESERVOIR ROCK.

Source Rock contains organic matter which forms oil and gas.

Source rock is impermeable.

Reservoir Rock stores the generated oil and gas.
The Reservoir rock is permeable and porous.

BASIC PROPERTIES OF PETROLEUM

Petroleum has three basic properties -

- It has a colour pattern ranging from colourless, through greenish-yellow-red and brown to black.
- It has a smell that ranges from being sweet, foul or fruity.
- The unit of measurement is in barrels.

CHALLENGES FACING THE PETROLEUM INDUSTRY

The petroleum industry faces four key challenges. These are,

- Locating the underground formations that may contain hydrocarbons.
- Drilling wells into rock formations.
- Encouraging hydrocarbons to flow from the rock formation to the well.
- Bringing hydrocarbons to the surface.

LOCATING PETROLEUM-RICH AREAS

Before drilling wells, companies acquire geophysical and geological information. The most important information usually comes from the analysis of geophysical data obtained from seismic studies.

When it is proven that underground formations contain hydrocarbons, only drilling can determine whether there are actually commercial quantities of oil or gas.

NATURAL RESERVOIRS OF OIL AND GAS

Natural accumulations of oil and gas in the earth's interior are called oil and gas reservoirs or pools. If a rock bed contains both oil and gas in a free state, the reservoir is called an oil-gas-gas pool. The oil-bearing bed (also called a formation) is usually bound at the top and bottom by impermeable rocks that do not allow oil and gas to penetrate into other strata. The thickness of oil and gas strata varies from a few centimeters to a few hundred of meters.

A collection of oil or gas pools located one above the other or over a certain area along the strike form an oil or gas field (deposit).

The number of oil or gas formations in different fields can vary from one to a few tens, so the fields can be single-horizon (single-layer) or multi-horizon (multi-layer) types.

TRANSPORTATION OF OIL AND GAS

Crude oil, condensate and natural gas generally have a limited application in the producing fields with the exception of natural gas, where a fraction of it might be used as fuel for internal combustion engines, heater-treaters, or other equipment.

The greatest demand for these petroleum fluids is in the consuming areas throughout the world.

Transporting petroleum fluids from the producing fields to the customers requires a complex network of systems. It may involve pipelines, transport trucks, railway tank cars, inland waterways, barges, and ocean-going tankers or a combination of several or all of these.

In this primer we shall discuss pipelines and focus mainly on gas pipelines.

PIPELINE

Pipelines are generally identified by their application, size, location and the specific liquid, gas or solid being transported. Crude oil pipelines include:

- Flow lines
- Gathering lines
- Trunk lines
- Distribution lines (also called products lines).

Natural gas pipelines include:

- Flow lines
- Gathering lines
- Transmission lines.

CRUDE FLOW LINES

A flow line is the pipe through which petroleum fluids flows from the well head to the tank batteries. It is the first surface pipeline that the fluid actually travels through. They are usually very short in length from only several metres to a kilometres in length depending upon the location of the tank batteries. The most commonly used pipe is two inches in diameter.

CRUDE GATHERING LINES

Gathering lines are used to transfer crude oil from tank batteries to a central location. They often consist of pipelines branches flowing into a pump station or other facilities where oil is transferred to a truck line system.

Gathering lines are the second phase of the transportation network for moving oil, except in cases where motor tank trucks are used to pick up oil from tank batteries.

As a general rule, gathering lines are longer than flow lines but shorter than truck lines. They may range from 4 inches through 12 inches in diameter, depending upon the quantity of oil transported.

CRUDE TRUCK LINES

Generally these pipelines are much longer and bigger in diameter than gathering lines and they move the lines from the gathering system to processing points or terminals for further handling.

Trunk lines are usually buried in the ground, except where conditions exist that warrant putting them above ground.

PRODUCT LINES

The product line system's role is primarily one of distribution of petroleum products from refineries to the storage and distribution terminals in the consuming areas.

Products shipped include several grades of gasoline, aviation fuel, diesel etc. The products pipelines can transport several products in the same pipeline in batches. Segregation of the shipments is sometimes achieved by the use of physical batch separators or the differences in densities.

OTHER TYPES OF PIPELINE

There are other types of pipelines besides oil and gas product lines. Some carry non-petroleum products, and others transport petroleum related products.

The non-petroleum lines include coal slurry pipelines and carbon dioxide pipelines.

Petroleum related products pipelines include Liquefied Natural Gas (LNG) lines which are usually in operation where LNG tankers are loaded and unloaded.

These pipelines are made of special steel and require super insulation to keep the product in a liquid state.

NATURAL GAS

Natural gas is one of the forms of energy. It is colourless, odourless and burns with an even temperature. As it burns, it leaves no harmful residue that would harm our environment. Burning of natural gas and its uses were known to the Chinese more than 2000 years ago.

THE COMPONENTS OF NATURAL GAS

The hydrocarbon gases normally found in natural gas are methane (which is the predominant component), ethane, propane, butane, pentane and small amounts of hexane, heptane, octane and heavier hydrocarbons.

Usually, the propane and heavier fractions (Natural Gas Liquid) are removed for additional processing because of their high market value as gasoline blending stock and chemical/petrochemical plant raw feedstock.

TYPES OF NATURAL GAS

There are generally four types of Natural Gas:

WET
DRY
SWEET
SOUR

Wet gas contains some of the heavier hydrocarbon molecules which are vital for processing operations and water vapour while it is in the reservoir. When this gas reaches the surface, some of the hydrocarbon molecules form a liquid at surface conditions.

Dry gas indicates that the fluid does not contain enough of the heavier molecules to form a liquid at surface conditions.

Sweet gas has a much lower concentration of sulphur compounds, particularly, hydrogen sulphide H_2S .

Sour gas contains excessive sulphur compounds which have an offensive odour and which are harmful to breathe. Exposure to it can cause death.

MAIN USES OF NATURAL GAS

Due to the variety of natural gas constituents, it finds wide application either as an energy source or as feedstock to chemical/petrochemical industries:-

- As an energy source – Natural gas competes with petroleum products, notably fuel oil, diesel and liquefied petroleum gas. It is less expensive, burns cleaner and is more abundant than all these other fuels. It is used as fuel to generate electricity and for firing kilns etc.
- As feedstock to chemical and petrochemical industries – natural gas and natural gas liquids are used to manufacture a gamut of intermediate chemicals and finished products such as ammonia, methanol and fertiliser.

- Natural gas can also be used as an automotive fuel – as Compressed Natural Gas (CNG), to run vehicles.

ADVANTAGES OF NATURAL GAS OVER OTHER ENERGY SOURCES

- Natural gas burns clearly, resulting in less maintenance of burner tips; there is no soot-blowing, no ash handling, no clearing up of oil spills, and less painting of soot-covered building and structures.
- It is more efficient as it can be used indirect firing.
- Natural gas is delivered through underground pipes and therefore, the supply is continuous and reliable.

GAS PIPELINES

When produced with crude oil, natural gas and crude oil both share the initial surface flow line from the well head to the gas separator. From the separator onward, the natural gas is transported in its own pipeline system.

Technically, a gas pipeline system is similar to both crude oil and products pipelines with respect to the actual pipe and fitting used and the methods of construction the system.

Gas is moved through the pipeline system by compressors and compressor stations by pumps and pumping stations. Gas pipeline system usually operates at higher pressures than crude or product lines.

Natural gas pipeline systems must maintain a certain pressure in order to supply a volume of gas to the customer. This is made possible by many factors including:

- an adequate supply
- proper pipe size
- regulating equipment
- compressor station

Flow lines connect individual gas wells to a gathering system that eventually run to a processing plant where gas is treated. Unwanted water is removed so that the specification for dry gas can be met.

The plant also removes propane, butanes, ethane and heavier hydrocarbon that have a marketable value.

From processing plants, dry natural gas enters the gas transmission system for delivery to industrial and domestic customers.

Gas transmission pipelines, like crude oil truck lines, are made of steel pipe with welded joints.

OFFSHORE PIPELINES

Some of the petroleum industry's greatest developments have been in offshore pipelining during the past few years.

Most offshore pipelines must be buried below the ocean bottom to protect the pipe from damage by ship anchors and natural hazards.

Coating is applied to the pipes for corrosion protection and coating of concrete is added to provide the weight needed to keep the pipe on the sea floor or in the trench. This is called "negative buoyancy"

OFFSHORE PIPE LAYING

There are three primary techniques used to lay pipelines offshore:

- Lay barge or "stovepipe" technique.
- Reel barge technique
- Pull method

In the **lay barge technique**, sections of the pipe, usually coated with concrete and welded together on a lay-barge are released into the water as the barge moves forward. Lay bays have been used for pipe as small as inches in diameter and as large as 52 inches in diameter.

In the **reel barge method**, long sections of pipe are welded on land, wound onto a large reel on the barge and then laid directly from the reel. Currently this technique is usually limited to pipe diameter of 12 inches or less.

The third method is to pull pipe from make-up-sink. In this approach, a length of pipe is assembled onshore, given auxiliary buoyancy with strapped-on tanks, floated to location, then sunk and connected to other sections with under water welds. Its use is limited by the requirement for calm seas and by the high cost of associated diving operations.

INLAND PIPELINE CONSTRUCTION

While all pipeline techniques have some common characteristic, the environment will dictate the final cost, the complexity and technology.

Planning a pipeline begins with both a supply of, and a demand for, the oil or gas that will economically justify the cost of building a line.

The following is a summary of the steps during construction:

a) RIGHT – OF WAY (ROW)

The company must obtain a ROW easement covering a strip of land 20 – 50 meters in width and the length of the property involved, before the actual cleaning and grading begins.

b) STRINGING THE PIPE

The pipe is handled to the ROW and strung into long sections by welding them to together.

c) DITCHING

This includes all excavation work that is required to provide a ditch of the specified dimension and depth usually about metre deep.

d) BENDING AND LAYING PIPE

Every time the ditch changes direction or elevation, the pipe must be formed to fit it. This is called BENDING.

Laying includes swabbing the pipe, buffing the levelled ends and lining it up for welding. Lining up consists of placing lengths of pipe in position with welding clamps and leaving a space between the faces of the pipe ends so that proper welding can be achieved.

e) WELDING AND INSPECTION

A complete weld may take from 2 to 5 passes to fill up levelled space between the 2 joints.

Visual inspection welds and observation of welding operations are relied upon for inspection. However, some contracts call for all or part of the welds to be X – rayed.

f) COATING AND WRAPPING

After welding, the pipe is ready for cleaning, priming, coating and wrapping. If there pipe has been previously prepared in a pipe yard only the welds need to be attended to.

g) LOWERING AND TIE-IN

Pipe may be lowered into the trench as part of the coating and wrapping process, thus reducing possible damage to the coating and eliminating an extra step in handling installation of valves and other pipe fittings requires breaks in the

continuity of the line. The welds connecting these various pipes sections into continuous pipelines are referred to as tie-on welds.

h) BACKFILLING

This is the process of pulling and backing the soil on top of the pipe in the trench.

i) TESTING

The purpose of testing is to locate any part of the system that might not withstand the designed working pressures plus pressures that are added for the test as a safety factor. Records of each test must be kept, and must include the date, proper identification of the pipeline or portion of the line tested, and the signatures of those responsible for the testing.

WHAT IS LNG?

The issue of whether a high pressure pipeline or Liquefied Natural Gas (LNG) carrier will deliver imported gas is primarily a function of whether the capital costs involved in transporting natural gas over long distances.

Presently, the cross-over point where it is most economical for LNG to be delivered than natural gas is 2000 km by submarine pipeline and 4500 kilometres by on-shore pipeline.

APPENDIX 5

Definition of Terminology

For the purpose of clarity and easy interpretation of terms used in this primer for all target groups, the following are some definitions:

Methane

A colourless, flammable, odourless hydrocarbon gas (CH₄) which is the major component of natural gas. It is also an important source of hydrogen in various industrial processes. Methane is a greenhouse gas.

Natural gas

A gaseous mixture of hydrocarbon compounds, the primary one being methane.

Wet natural gas

A mixture of hydrocarbon compounds and small quantities of various non-hydrocarbons existing in the gaseous phase or in solution with crude oil in porous rock formations at reservoir conditions. The principal hydrocarbons normally contained in the mixture are methane, ethane, propane, butane, and pentane. Typical non-hydrocarbon gases that may be present in reservoir natural gas are water vapour, carbon dioxide, hydrogen sulphide, nitrogen and trace amounts of helium. Under reservoir conditions, natural gas and its associated liquefiable portions occur either in a single gaseous phase in the reservoir or in solution with crude oil and are not distinguishable at the time as separate substances.

Associated-dissolved natural gas

Natural gas that occurs in crude oil reservoirs either as free gas (associated) or as gas in solution with crude oil (dissolved gas).

Non-associated natural gas

Natural gas that is not in contact with significant quantities of crude oil in the reservoir.

Dry natural gas

Natural gas which remains after:

- (1) the liquefiable hydrocarbon portion has been removed from the gas stream (i.e., gas after lease, field, and/or plant separation); and

- (2) any volumes of non-hydrocarbon gases have been removed where they occur in sufficient quantity to render the gas unmarketable.

Natural Gas Measure

Natural gas is usually measured in volumetric terms such as cubic feet or cubic metres. A cubic metre contains roughly 35.3 cubic feet. One can also measure natural gas in its heat content. The most common unit for measuring heat content is British thermal units or Btu, which is the amount of heat required to raise the temperature of one pound of liquid water by 1 degree Fahrenheit at its maximum density, which occurs at a temperature of 39.1 degrees Fahrenheit. One Btu is equal to approximately 251.9 calories or 1055 joules.

Exploration

The activities that lead to discovery of new natural gas resources. Exploration risk is one of the strongest forms of risk.

Production

Extraction of discovered supplies from hydrocarbon fields either with crude oil (as associated natural gas) or separately (non-associated natural gas). If natural gas is associated with crude oil, it must be separated.

Gathering

This is the collection of natural gas production from multiple wells connected by small diameter, low pressure pipeline systems and delivery to a processing plant or long-distance pipeline.

Processing and treatment

Processing is the separation of heavier molecules and unwanted substances such as water from methane gas stream. If the gas stream contains impurities such as hydrogen sulphide then treatment is required.

Storage

Containment of supplies, usually in depleted underground reservoirs or caverns like those associated with salt domes, but also in above ground storage tanks in liquefied form. Storage can be located either near production or near demand.

Transportation

Delivery of gas from producing basins to local distribution networks and high-volume users via large diameter, high volume pipelines.

Liquefaction, shipping and re-gasification

Known collectively as the LNG value chain, this entails conversion of gas to a liquid form via refrigeration to result in a cryogenic fluid (temperature -256°F) for transportation from a producing country or region to a consuming country or region via ship. LNG is stored until it is returned to the gas phase (re-gasification, using vaporization) for pipeline transportation within the consuming region.

Distribution

Retail sales and final delivery of gas via small diameter, low pressure local gas networks operated by local distribution companies or LDCs (often termed gas utilities).

End use and conversion

Direct use or conversion for use in other forms (petrochemicals, electric power or vehicle fuels).

Aggregation

Consolidation of supply obligations, purchase obligations or both as a means of contractually – as opposed to physically – balancing supply and demand.

Marketing

Purchase of gas supplies from multiple fields and resale to wholesale and retail markets. Retail marketing constitutes sales to final end users (typically residential, commercial, industrial, electric power and public sector).

Capacity brokering

Trading of unused space on pipelines and in storage facilities.

Information services

Creation, collection, processing, management and distribution of data related to all the other industry functions listed here.

Financing

Provision of capital funding for facility construction, market development and operation start-up.

Risk management

Balancing of supply, demand and price risks.

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