Petroleum

1. Introduction to oil and gas

Some Stylish Facts

i. Oil is the only form of energy that is traded on the International market
ii. It was discovered commercial quantities in 1859 by William A. Smith and Colonel Drake.
iii. More than two thirds of oil reserves are in the Middle East
iv. Saudi Arabia is the leading Producer whilst the USA is the leading consumer with China as second.

Terminologies

- Reserves: Reserves are those quantities of hydrocarbons which are anticipated to be commercially recovered from known accumulations from a given date forward
- Probable Reserves: These are those unproved reserves in which analysis of geological and engineering data suggests a more likelihood than not to be recoverable
- Proved Reserves: These are those mass of petroleum that can be estimated with reasonable certainty to be commercially recoverable by analysis of geological and engineering data, from a given date forward, from known reservoirs and under contemporary economic conditions, operating methods, and government set of laws. Proved reserves can be classified as development or undeveloped.
- Possible Reserves: less likely to be recoverable than probable based on geological and engineering data

Oil Grade

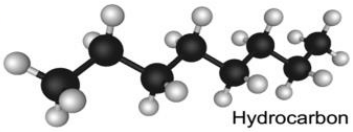
Oil can be sweet, sour, light, heavy or combination of sweet and light, or heavy and sour or other combinations.

- Light Crude grades have low viscosity and contain higher amount of distillate.
- Heavy crude grades have high viscosity and contain less lighter products.
- API gravity of 34 or higher is "light", between 31-33 is "medium", and 30 or below is "heavy".
- Sweet vs. Sour Crude
- Sweet crude grades contain less than 1% Sulphur
- Sour grades contain higher amount of Sulphur

1.1 Formation of oil and Gas

Origin : Chemistry

Crude Oil



Hydrocarbon

- Oil and gas are made of a mixture of different hydrocarbons.
- As the name suggests these are large molecules made up of hydrogen atoms attached to a backbone of carbon.

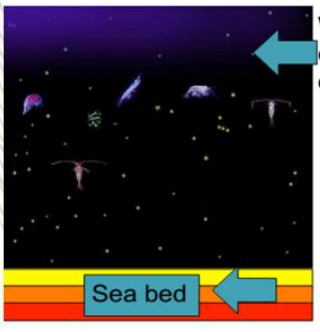
Origin : Plankton

Plant plankton

Animal plankton

- Most oil and gas starts life as microscopic plants and animals
  that live in the ocean.

Origin : On the sea bed

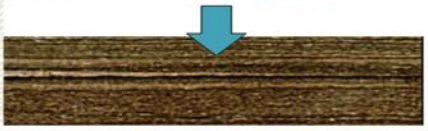


When the plankton dies it rains down on sea bed to form an organic mush

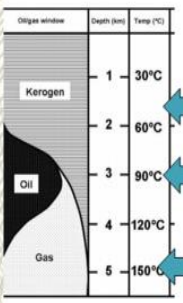
If there are any animals on the sea bed these will feed on the organic particles

Origin : Black Shale

- However, if there is little or no oxygen in the water then animals can't survive and the organic mush accumulates
- Where sediment contains more than 5% organic matter, it eventually forms a rock known as a Black Shale



Origin: Cooking



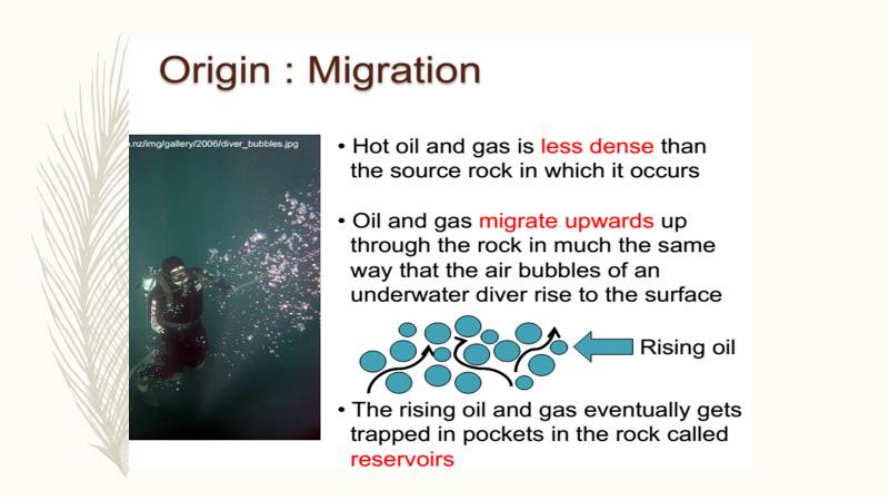
As Black Shale is buried, it is heated.

Organic matter is first changed by the increase in temperature into kerogen, which is a solid form of hydrocarbon

Around 90°C, it is changed into a liquid state, which we call oil

Around 150°C, it is changed into a gas

A rock that has produced oil and gas in this way is known as a Source Rock



1.2 Natural Gas

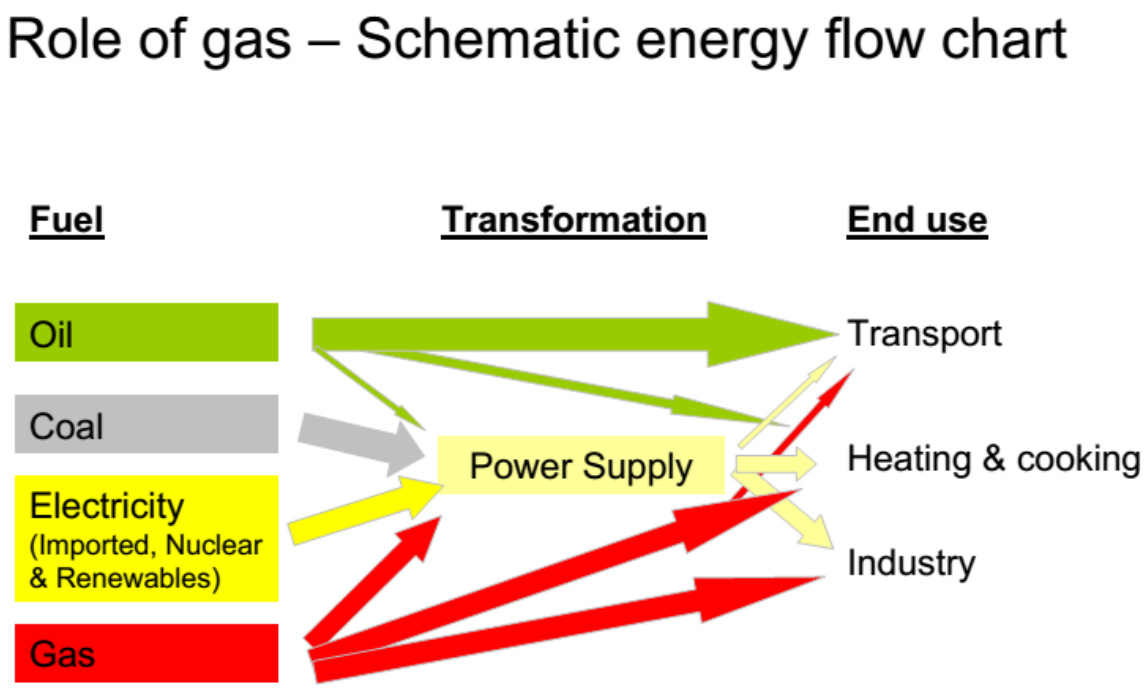
- Natural gas is a hydrocarbon fossil fuel
- Its formation is similar to other liquid hydrocarbons
- Colourless, odourless, lighter
- Cleaner-burning (less sulphur and carbon emissions)
- Typically it contains some NGLs and condensates, as well as additional elements as shown on the right

Natural gas is typically made up of;

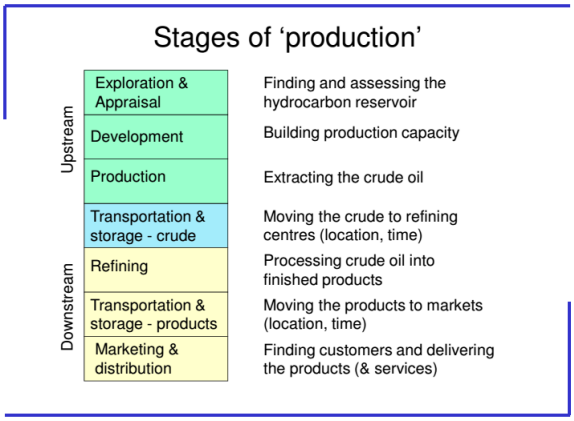
Methane	CH4	70-90%
Ethane	C2 H6	0-20%
Propane	C3 H8	
Butane	C4 H1 0	
Carbon dioxide	CO2	0-8%
Oxygen	O2	0-0.2%

Nitrogen	N2	0-5%
Hydrogen sulphide	H2 S	0-5%
Rare gases	A, He, Ne, Xe	Trace

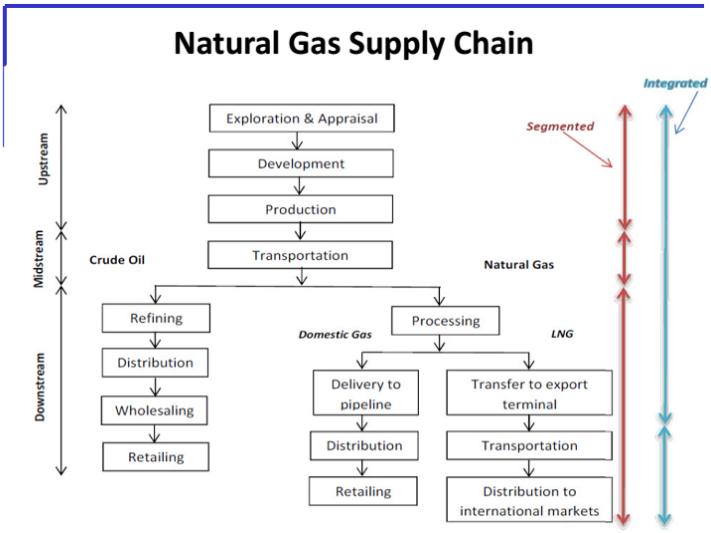
1.3 Uses of Natural Gas



2. The Oil Value chain



2.1 Natural gas value chain



3 Oil and Gas Value Addition

3.1 Oil Refining

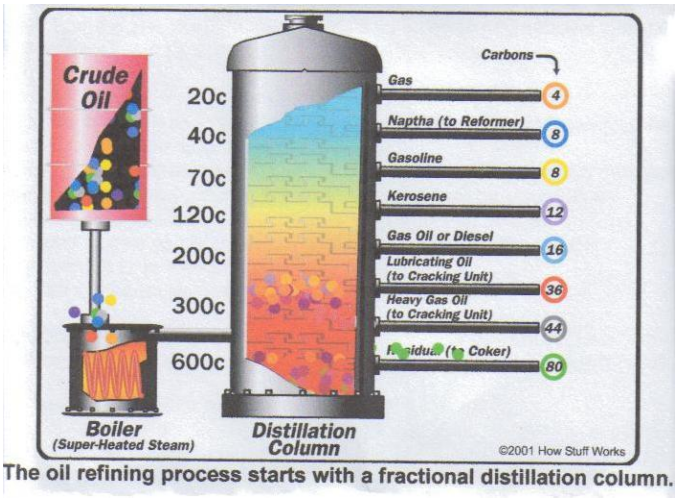
Crude oil in its natural state has no value to consumers and must be transformed into products that can be used in the marketplace.

Various physical and chemical methods are used in refining processes.

Heat, pressure, catalysts, and chemicals are applied under widely varying process designs, operating conditions, and chemical reactions to convert crude oil and other hydrocarbons into petroleum product

An oil refinery converts crude oil into marketable products applying both physical and chemical processes.

The refining of crude oil produces a variety of products including gasoline/Petrol, diesel fuel, jet fuel, home heating oil, and chemical feedstock



The oil refining process starts with a fractional distillation column.

The Tema Oil Refinery has capacity to refine 45000 barrels per day.

3.2 Natural Gas Processing

Conventional natural gas is produced from three types of wells:

i. Gas wells produce non associated gas
ii. Oil wells produce associated gas in the form of dissolved gas or free gas
iii. Condensate wells produce gas with condensate also called natural gas liquids

Raw natural gas are processed near or at the wellhead for transportation to end users

The process usually involve four stages:

i. Remove oil & condensate
ii. Remove water
iii. Remove NGLs
iv. Remove sulfur and Carbon Dioxide

3.3 Natural Gas Transportation

The 2 major Forms of Natural Gas Transportation are

- Pipelines

- Ships – Liquified Natural Gas (LNG)

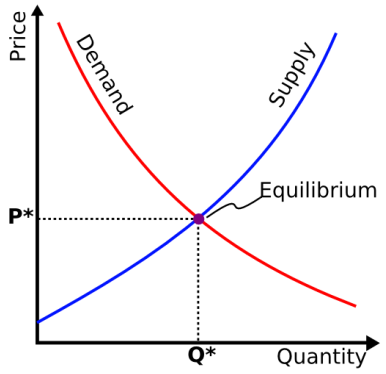
3.4 LPG Vs LNG

- Liquid Petroleum Gas (LPG) is the generic name which is given to the commercial gases, propane and butane.
- Liquid Natural Gas (LNG) is methane that has been cooled to around –162°C, at which temperature it liquefies and can be transported in insulated tanks aboard specialised vessels.

4 Economics of Oil and Gas

4.1 Crude Oil Pricing

Oil prices are determined by demand and supply.



Oil prices are Market determined

Key factors at Play:

1. Market Fundamentals: The forces of demand and supply

2. Geopolitical Factors

3. Speculation

Demand Factors: some of the factors that influence demand includes:

- Economic Growth (proxy GDP)
- Seasonality
- Population Growth – Medium to long Term change in underlying demand
- Policy Action: Climate and Environmental Factors - Medium to long Term change in underlying demand

Supply Factors: some of the factors that influence supply includes:

- broadly the proxy for determining the level of market supply include oil Rig Activity (i.e. proxy Rig Count) short term factor – the number of active oil rigs is seen as an early indicator of future output levels.
- Inventory Levels/ stock (Proxy USA inventory levels), short term factor
- OPEC Activities (output Restrictions/output increase) short term factor
- New Discoveries – Massive new discoveries like US Shale oil
- Technology - Medium to long Term change

Demand Side Impact from Geopolitical developments globally – here the focus is on geopolitical developments in the major oil consumption (Demand) markets.

- E.g. Europe (EU), Asia (China, Japan, South Korea, India) and USA.
- How does Brexit (a geopolitical issue in Europe) impact on near term potential future demand, through growth disruption within the EU Post Brexit, Uncertainty?
- How does the USA – China Trade war impact on potential productivity through trade/export restrictions etc?
- Covid

4.2 Petroleum Downstream

- Regulated by National Petroleum Authority
- 39 Bulk Distribution Companies
- 185 Oil Marketing Companies
- Price is determined by a combination of factors such as the exchange rate, international oil price and the cost of transporting the oil to Ghana, margins of companies that import and those that sell and government taxes and levies

4.3 Natural Gas Pricing

Often, natural gas price is made up of;

- gas commodity price
- gas pipeline tariff
- gas gathering

- gas transmission
- gas distribution
- gas processing fee
- levies, margins and taxes (where applicable

The price of gas is affected by some of these factors;

- Pipeline or LNG imports may supplement domestic supply, so any disruption to them or change in their prices will affect domestic prices
- Oil prices can affect gas prices. Directly, if gas prices are pegged on oil (e.g. Russian exports and Japanese LNG imports). Indirectly, if the level
- The level of economic activity will affect the overall level of energy demand and will move it in the same direction depending on the income elasticity of energy demand
- Natural catastrophes, political events and other wild cards may affect supply/demand and prices. E.g. hurricane Katrina disrupted production, Fukushima knocked out nuclear generation which had to be replaced by gas power
- Weather conditions and extremities affect demand. A cold winter spurs residential and commercial demand for heating

5 Oil and Gas Regulation in Ghana

5.1 Evolution of Regulation

With the significant oil discovery in 2007, it was realized that the state management and control of the industry would only be ensured through extensive legislation and effective monitoring by competent authorities.

Prior to major commercial discovery the laws which governed the industry were:

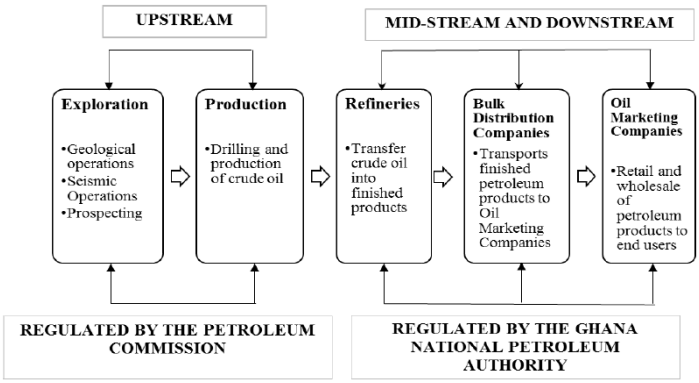
- Petroleum Exploration and Production Law 1984, PNDC Law 84
- Ghana National Petroleum Corporation Law 1983, PNDC Law 64
- Petroleum Income Tax Law 1988, PNDC Law 188

The above three Laws were synthesized into the Model Petroleum Agreement which formed the basis for negotiating Petroleum Agreements or Contracts. Since commercial production, a number of laws and regulations have been passed. These include;

- Income Tax Act (2015), Act 896
- Petroleum Commission Act 2011 Act 821
- Petroleum (Exploration and Production) Act, (2016) Act 919
- Petroleum Revenue Management Act
- Petroleum (Local Content and Local Participation) Regulations, 2013 (L.I. 2204)
- Petroleum Commission (Fees and Charges) Regulations, 2015 (L.I. 2221)

- Petroleum (Exploration and Production)(Measurement) Regulations, 2016 (L.I. 2246)
- Petroleum (Exploration and Production)(Health Safety and Environment Regulations) Regulations, 2017 (L.I. 2258)
- Petroleum (Exploration and Production)(Data Management) Regulations, 2017 (L.I. 2257)

5.2 Institutional roles



Institutions have been established and strengthened to oversee the upstream petroleum industry.

i. Petroleum Commission
Established to regulate and manage the utilization of petroleum resources and coordinate sector policies.

ii. Ghana National Petroleum Company
The commercial arm through which the State participates in the upstream petroleum sector.

iii. Ghana National Gas Corporation
Incorporated to operate infrastructure for gas processing to ensure the utilization of indigenous gas resources for power generation, provide feedstock for petrochemical industries and to support the national policy of zero gas flaring.

iv. Public Interest and Accountability Committee
Established to deal with compliance with the Petroleum Management Act, create a platform for public engagements on oil revenues and monitor and report on oil revenue management.

5.3 Local Content

Local Content Regulations (L1 2204), which is enforced by Petroleum Commission seeks to;

(a) promote the maximization of value-addition and job creation using local expertise, goods and services, businesses and financing in the petroleum

industry value chain and their retention in the country;

(b) develop local capacities in the petroleum industry value chain through education, skills transfer and expertise development, transfer of technology and know-how and active research and development programmes;

(c) achieve the minimum local employment level and in-country spend for the provision of the goods and services in the petroleum industry value chain as specified in the First Schedule;

(d) increase the capability and international competitiveness of domestic businesses;

(e) create petroleum and related supportive industries that will sustain economic development;

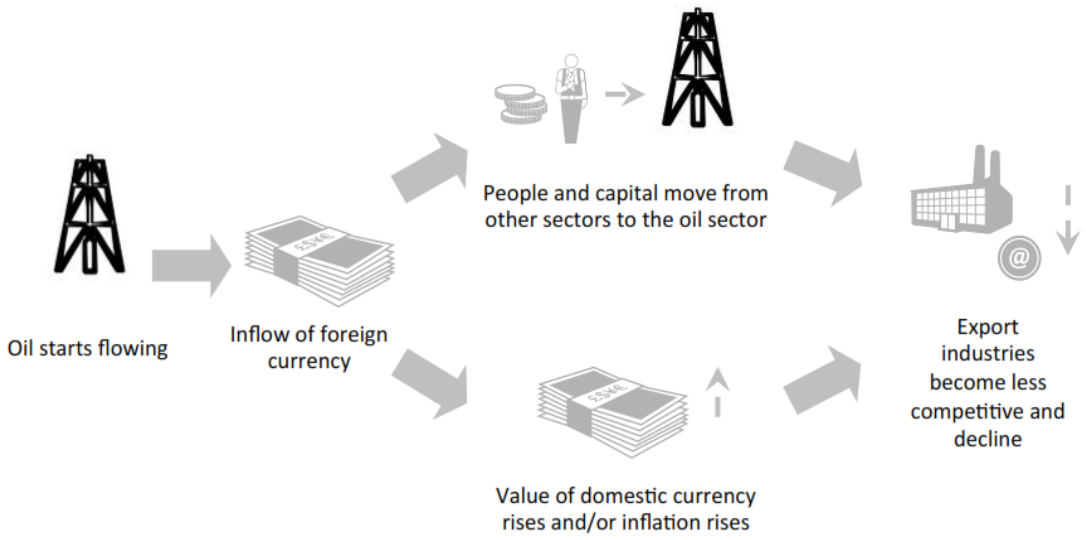
(f) achieve and maintain a degree of control for Ghanaians over development initiatives for local stakeholders;

5.4 Petroleum Revenue Management

Petroleum revenue management frameworks help countries translate oil and gas resources into sustainable development and overcome challenges such as the Dutch disease.

Illustration

- Let's assume that The whole economy can be divided into the Non-tradable Sector and the Tradable Sector.
- The Non-tradable Sector consists of those industries or activities the prices of which are determined by demand and supply domestically. It is dominated by services of various kinds.
- The Tradable Sector consists of export and import-competing industries. These are industries the prices of which are determined, at least to a considerable extent, in the world market, set by world prices and the exchange rate.
- The Tradable Sector can be divided between the Booming Sector and the Lagging Sector
- The Booming Sector consists of the oil mining industries
- The Lagging Sector consists of the export and import- competing industries that lag behind consists of a part of manufacturing industry, of part of agriculture and of certain services, principally those provided by the tourism industry and the export-of-education industry



- The spending effect comes into play when increased domestic income from the booming natural resource sector leads to higher aggregate demand and spending by the public and private sectors.
- Increased demand for non-tradables leads to higher prices and output in the non-tradables sector.
- Wages in the economy will tend to rise, squeezing profits in the non-resource tradables sector ("manufacturing"), where prices are fixed at international levels.
- The resource movement effect takes place when a boom in the natural resource sector attracts capital and labour from other parts of the economy.
- It tends to reduce output in the rest of the economy.
- In particular, reduced output in the non-tradables sector causes the price of non-tradables to rise relative to the price of tradables, which are set in the world market.
- For instance, a landlord would seek to rent his house to an employee working for an oil
- company as he would expect higher rent than that what he would receive from a farmer

Currency Appreciation

- The boom in an energy sector causes an inflow of foreign currency.

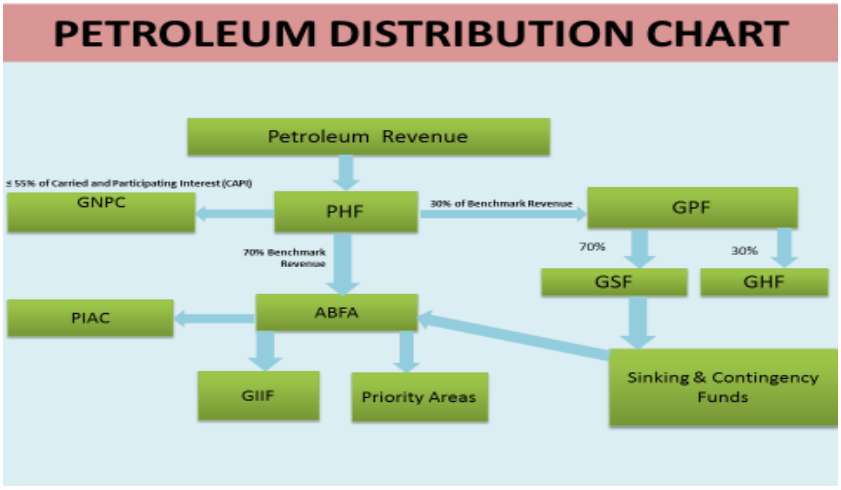
- This influx of foreign monetary units leads to appreciation of national currency. Appreciation makes a cost of domestically produced tradable goods higher.

- Because the price of manufacturing goods determined in the world market, and since the price of domestically made goods becomes higher, there is decrease in demand for tradable goods.
- As the law of supply and demand states increased supply of any product or service (in this case it is foreign cash) will decrease its relative price.
- In another word, increased supply of foreign cash increases value of national currency causing national exchange rate appreciation.
- Domestic exchange rate appreciation means that products produced domestically cost more in the world market than products produced in other countries.
- The domestic price appreciation decreases country's competitiveness in the world market.
- Decrease in competitiveness mainly hurts manufacturing sector; because of high price of domestically produced goods, a country cannot sell these goods on the world market.
- Decreased demand for produced goods causes a decline in a manufacturing sector.
- Manufacturing companies in response to decreased demand cut production by massive layoffs.
- Massive layoffs lead to high unemployment. Decrease in production within country causes decrease in Gross Domestic Product.

Some Policy Responses

- Diversification
- Hedging
- Stabilization Funds
- Fiscal Rules

Ghana's Petroleum Revenue Management Framework



- Under the PRMA, the GNPC receives 55 per cent or less of the carried and participating interest.

- The budget receives 70 per cent or less of the benchmark revenue (Diversification strategy). The benchmark revenue is the expected petroleum revenue based on a seven-year moving average. The percentage of petroleum revenue that goes into the budget is the annual budget funding amount (ABFA). The ABFA is shared between the priority areas, the Ghana Infrastructure Investment Fund and the PIAC.
- The remaining 30 per cent of the benchmark revenue goes to the Ghana Petroleum Funds, which is shared between the GSF (21 per cent) and the GHF (9 per cent).
- The GSF is used to cushion government expenditure when there is a petroleum revenue shortfall, and an excess of the cap is sent to the sinking (debt repayment) and contingency funds. The GHF is an endowment for future generations.
- The PRMA sets out the framework to regulate the allocation and management of revenues realized from petroleum production in Ghana.
- According to Section 7 of the amended PRMA (Act 893), the Minister for Finance can recommend a revision of the benchmark revenue to parliament if it becomes evident that unexpected changes in price or quantity can lead to high over or under projection. The amendment of sections of the Act in 2015 was intended to strengthen it and make compliance easier.