New Exploration Hotspots: Ranking of Attractiveness on Selected Countries

By

Mohd Shamim Bin Ahmad

16906

Dissertation submitted in partial fulfillment of the requirements for the

Bachelor of Engineering (Hons) Petroleum Engineering

FYP II MAY 2015

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CERTIFICATE OF APPROVAL

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CERTIFICATE OF ORIGINALITY

This originality certification is to that I am responsible for the work of this project and all the works are the original works of my own except as stated in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(MOHD SHAMIM BIN AHMAD)

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ABSTRACT

Exploration hotspot is defined as the next potential places for the exploration and production activities of oil and gas. The large discoveries being made in the hotspot regions in the past few years have attracting the interest of the investors especially oil and gas companies. These locations have emerged due to the need of meeting the oil and gas demand by the world, to counter the decline in production from mature fields, to move away from traditional/production resource centre, and to ensure energy security and boost the economy of a country especially in African region. Eight countries have been selected to be analysed for this study. This study will be focusing on finding the best exploration hotspot for the upstream investment. All selected countries are going to be assessed based on four main parameters which are resource potential, fiscal terms, accessibility and country risk. All the parameters will then be given a weightage based on their level of significance. Finally, these countries will be ranked in order to find the best exploration hotspot for the upstream investment to be made. This study has found that Mexico is the best hotspot for the upstream investment. It is followed by Myanmar, Gabon, Cote d'Ivoire, Angola, Kenya, Tanzania and Mozambique. Lack of infrastructures and tougher fiscal terms have hindered the development in the Africa region and country risk is still a major issue in all the assessed countries.

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CHAPTER 1

INTRODUCTION

1.1 Background

With the fields around the world are starting to mature, majors and other oil and gas companies are starting to look for other alternatives to counter the decline in production from these fields. One of the alternatives is to start exploring in new areas. The theories of Latin American Transform Margin (LAEM), West African Transform Margin (WATM) and East Africa Rift Plays (EARP) are very promising. Mexico opening, lifted sanction in Myanmar and Brazil/West Africa pre-salt have also emerge as the next potential places for the exploration and production of oil and gas. These new exploration areas are called exploration hotspots (Exploration - the 2014 hotspots, 2014)

The oil and gas companies across the world are ready to start investing in these countries as they look forward to increase the oil and gas production and also to generate profit/income for themselves. The demand for energy around the world is increasing due to rapid increase in population and urbanization (Carbajal, Demierre, Bazilian, Sherpa, & Modi, 2014). According to Wood Mackenzie, the demand for oil and gas in 2030 will reach 2966 Mtoe. The huge discoveries in recent years by these countries – especially Tanzania (28 tcf from 5 blocks) and Mozambique (100 tcf) - make them attractive enough for the investors to start exploring in these regions in order to meet the demand (Mozambique and Tanzania Upstream Summary, 2014).

This study will focus on the exploration in deep-water region as most of the reserves discovered in the past 3 years have been from deep-water areas. Most of the fields

discovered between 2012 and 2014 were from the deep-water region. There were 93, 83 and 58 number of deep-water fields found globally in 2012, 2013 and 2014 respectively (IHS, 2014). Other than that, exploration in pre-salt areas such as Angola and Gabon is also going to be included in this study. The driving factor for the pre-salt areas to be included in this study is mainly because of the success in Brazil's pre-salt especially from Santos and Campos Basins. Petrobas has announced that the production from pre-salt areas has reached 343 MMboe in between September 2008 to April 2014 (Oil and Gas Journal, 2014).

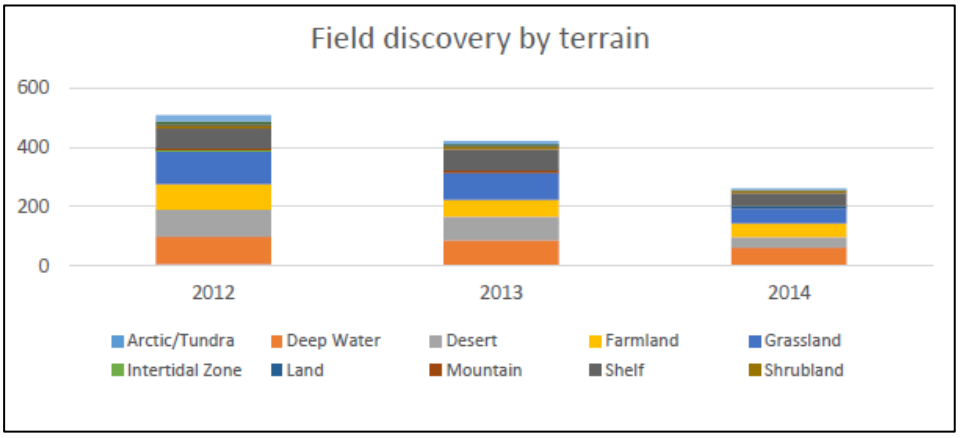

Figure 1: Field discoveries by terrain

1.2 Problem Statement

The trend of looking into new exploration hotspots has emerged as a result of trying to move away from the traditional resource centre (e.g. OPEC) and creating a stabilize market. Other than that, some of the countries, especially in Africa have opened up for the development of their oil and gas industry. Furthermore, decline in production from the mature fields around the world like in Mexico and UK North Sea has encouraged the oil and gas players to look for new exploration areas across the world. This study will analyse the countries identified as the new exploration hotspots and the problem statements for this study are as follows:

1. How much are the oil and gas resources in the selected countries that are yet to be discovered?
2. Are there any open blocks and farm-in opportunities in these countries and will they hold bid rounds in the near future?
3. Which country provides the best fiscal regime for the investment to be made?
4. What are the risks posed by these countries and how it will affect the development of oil and gas industry?

1.3 Objectives and Scope of Study

1.3.1 Objectives

The objectives of this study are to:

1. Analyse and rank these countries in order to find the best exploration areas based on four main criteria:
    - Resource Potential.
    - Fiscal Terms.
    - Accessibility.
    - Country Risk.
2. Find the best new exploration areas in order to meet the demand made by the world in the future, to arrest the decline in mature fields, to move away from the traditional resource/production centre, to ensure energy security and to boost economy.

1.3.2 Scope of Study

This study consists of 8 selected countries that are going to be analysed based on four main criteria as been discussed in the first objective. The parameters involved are country resources, accessibility, fiscal regime and country risk. 5 of the countries selected which are Mexico, Angola, Gabon, Cote d'Ivoire and Kenya are zones identified as oil prone. The other 3 countries, Tanzania, Mozambique and Myanmar have been recognized as the gas prone locations.

Table 1: Country Classification

Oil prone	**Gas prone**
Mexico	Tanzania
Angola	Mozambique
Gabon	Kenya
Cote d'Ivoire	
Kenya	

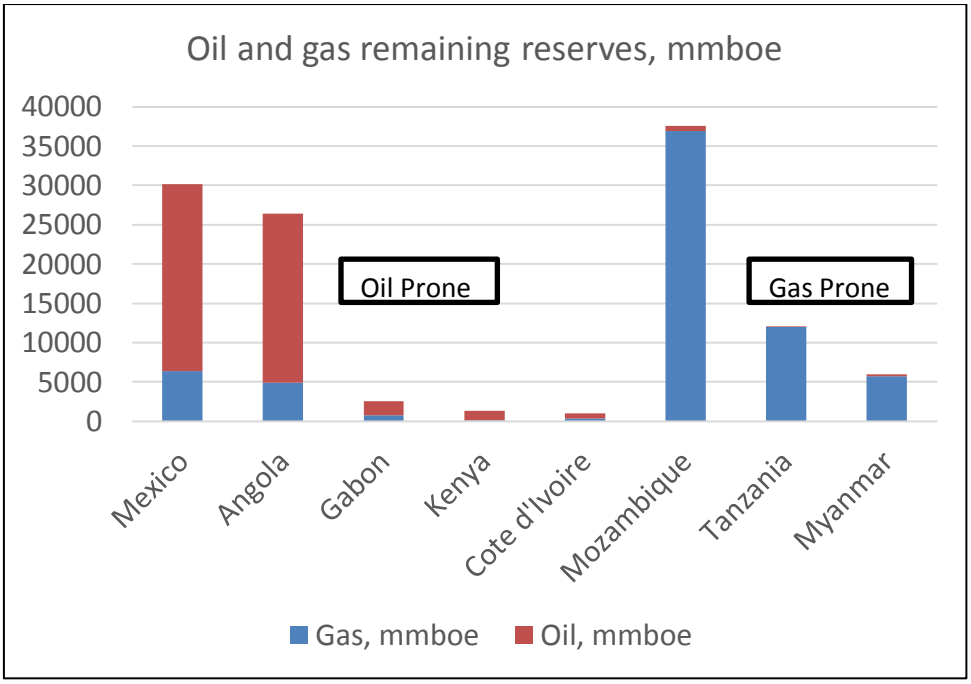

Figure 2: Oil and gas remaining reserves

1.3.2.1 Mexico Opening

Mexico is ready to open their oil and gas industry to foreign investment after 75 years of PEMEX monopoly (Energy Intel). The purpose of this move is to counter the decline in oil production especially from the mature fields in Mexico.

1.3.2.2 West African Pre-Salt – Angola and Gabon

Technology advancements in 1980s and 1990s has led to the discovery of Brazil's pre-salt in the Santos Basin. The experience of the operators in drilling through deep-water and ultra-deep-water regions has helped them to drill through the pre-salt formation. The pre-salt reservoir is different to the conventional reservoir as it contains unusual microbiolitic carbonate. Brazil's pre-salt basin has been spreading alongside the West African countries like **Angola and Gabon**. This theory has been confirmed by the drilling result that shows drilling in both sides have penetrated the same geologies of lacustrine rocks of Jurassic and Lower Cretaceous age. The pre-salt basins in this region has been split long ago by the continental drift and plate tectonics event. However, it is not easy to drill through the pre-salt basin. The problems are:

- Data processing will be complicated as the seismic velocity between the salts and sediments are different. The joint data between EM and seismic are needed to overcome this problem.
- Salt will reduce drilling fluid ability to carry the cuttings to the surface.
- Heterogeneous layered carbonate formation will cause problem to the drilling progress.

Pre-salt is a layer of salt and carbonate formation located inside the earth's crust. Under this formation, there are deposits of hydrocarbon. Pre-salt layer is considered as the ultra-deep water situation because the water depth can reach 23,000 ft (Mainwaring, 2013). The exploration and development processes will be difficult with this kind of depth. Other challenge of doing exploration in pre-salt area is reservoir quality predictability. In addition, it is hard to achieve the increased in penetration rate through salt and carbonate formation due to different velocities in different components of salts (Coajou, 2015). In Angola's Ogonga-1 well, the ROP is reduced due to the hard mineral rocks under the salt layer (Wood Mackenzie, 2013). Other problem that might be faced in drilling pre-salt deposits are the water-flood process

can cause swelling of clay and causing the pore spaces to be clogged. Clay is really sensitive when there are presence of water.

Figure 3: West African Pre-Salt Map

1.3.2.3 West African Transform Margin – Cote d'Ivoire

The theory of the West African Transform Margin was created when Kosmos Energy (US firm) and Anadarko discovered Jubilee and Venus fields in 2007 and 2009 respectively. Jubilee, located offshore Ghana was discovered in June 2007 and two years later, Venus field was found in Sierra Leone. The distance between these two fields are estimated to be 1100 km. With these two new discoveries, geologists have agreed that it can represent a new petroleum geology along the West African countries from Ghana, Liberia, **Ivory Coast** and Sierra Leone. Majors have been in these countries before but no major discoveries were made. According to Kosmos, those companies were looking into the wrong type of structure. Kosmos suggests that companies should focus drilling through the stratigraphy traps instead of structural traps. Other than that, they also believe that the good source rock is located in the upper cretaceous rather than lower cretaceous. That is why they are focusing into the deep-water region for their exploration activities.

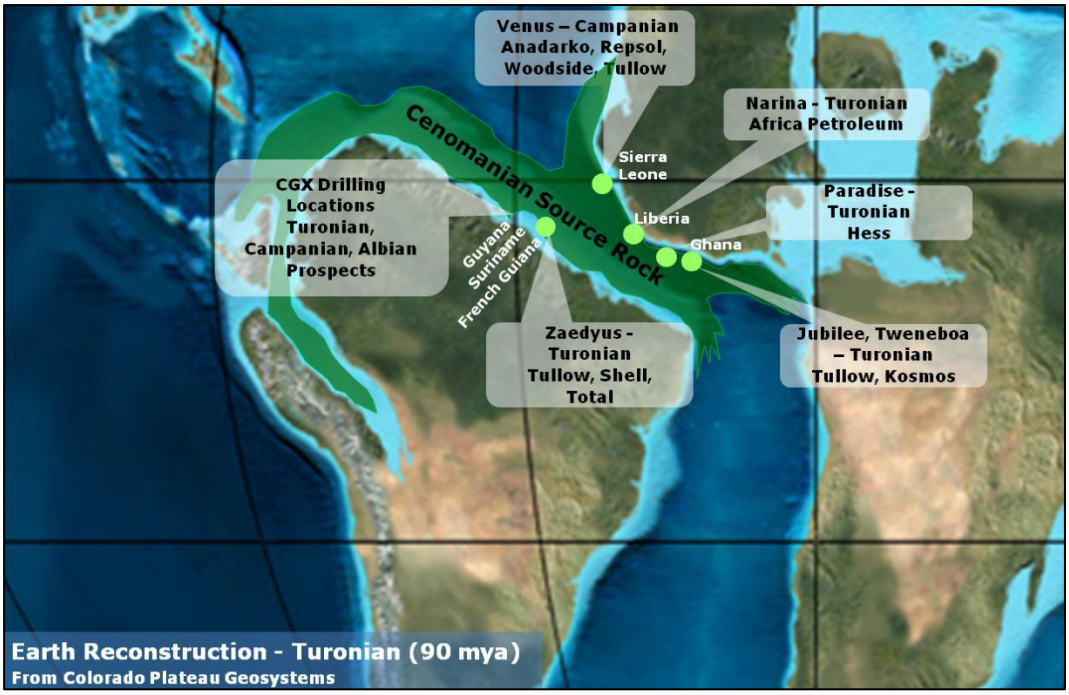

Figure 4: West African Transform Margin

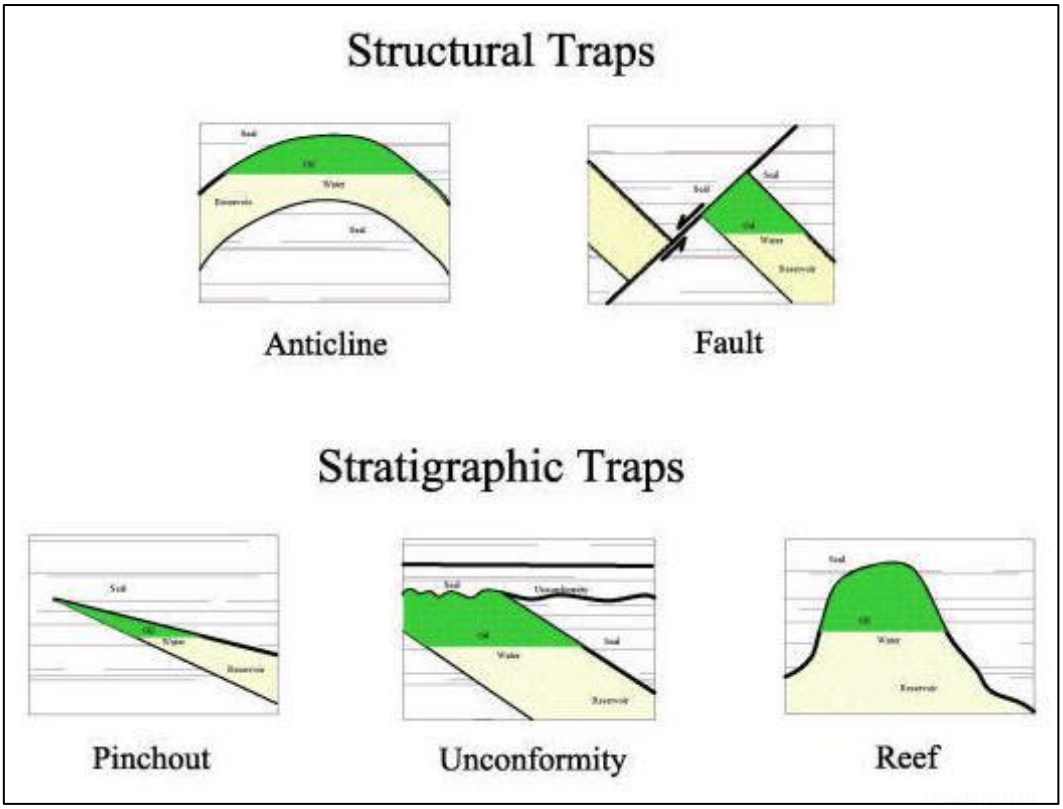

Figure 5: Type of traps

1.3.2.4 East African Rift Play – Tanzania, Kenya and Mozambique

East African Rift Play is ranging 5000 km from Ethiopia to Mozambique. Similarities have been found in petroleum system of Somaliland and the proven hydrocarbon region of Yemen. There are differences between West Branch and East Branch in the northern section of the study area. For the West Branch, it is started in the Albertine Graben in Northern Kenya. A high level of seismic activity, less volcanic activity and greater thickness of sediments have been recorded in West Branch compared to the Eastern Branch. However, Eastern Branch also has a good prospect in the Turkana Depression region where a study found that it has a great prospect of hydrocarbon activity.

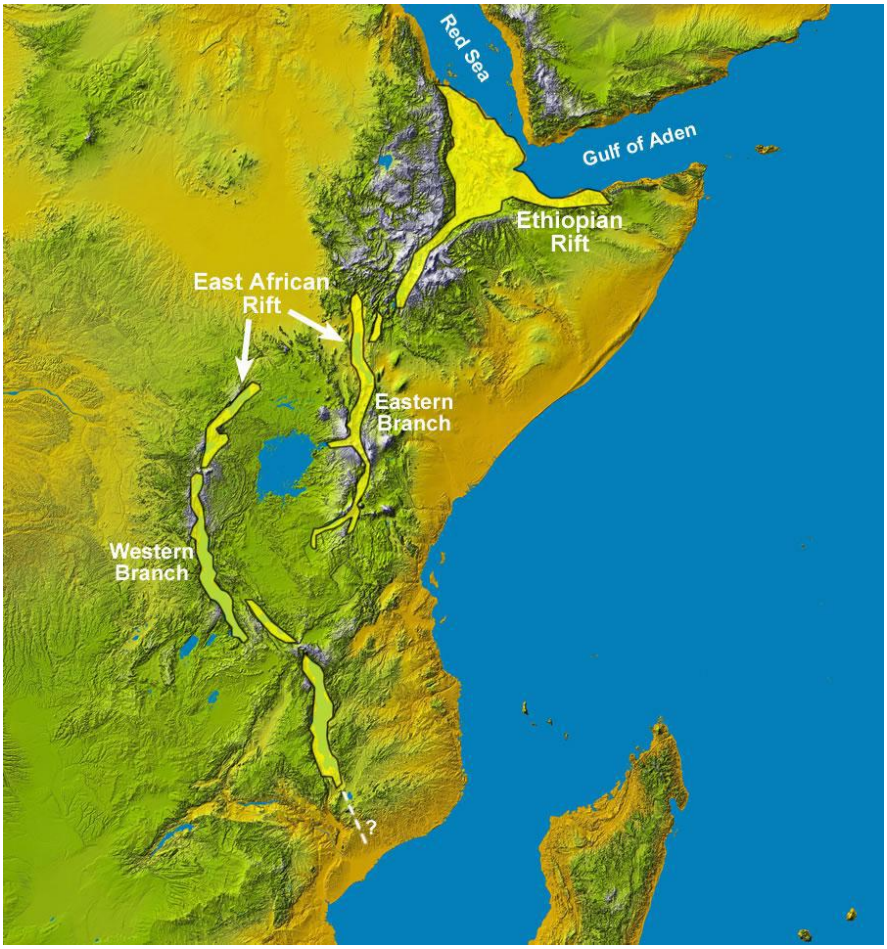

Figure 6: East Africa Rift Play Map

1.3.2.5 Lifted Sanction in Myanmar

First phase of economic sanction that has been lifted in 2011 allows Myanmar to develop their oil and gas resources (Myanmar Upstream Summary, 2014). Since then, Myanmar has working hard to attract foreign investments for their oil and gas industry. They are doing this by providing an improved and transparent financial laws and also attractive fiscal term for the investors. Myanmar has started to hold bid rounds. The first bid round was successfully conducted in 2011. The exploration and production activities have been dominated by their state owned company, MOGE. In order to meet the domestic demand, Myanmar has decided to open their oil and gas industry to the private investments.

CHAPTER 2

LITERATURE REVIEW

Exploration hotspot is referring to a location with a big potential of becoming the next exploration centre due to the large discoveries been made and impressive drilling success in recent years. Brazil, Mozambique, Tanzania, Angola and Gabon are examples of the countries that can be categorized as the exploration hotspots. Some of the countries listed as exploration hotspots have the pre-salt formation like Brazil, Angola and Gabon. This formation was first found in Brazil. A few years after the discovery in Brazil, discoveries were also made in some of the West African countries like Angola and Gabon (GeoExPro, 2009). For East African countries like Tanzania, Mozambique and Kenya, this location is a deep-water zone with gas prone (GeoExPro, 2009). These new emerging hotspots have attracted the attention of oil and gas companies to start some exploration activities in the past few decades. There are few reasons that have triggered the emergence of these new exploration hotspots. Some of them are due to **increase in energy demand** and also to **create market stability**. This study is done in order to analyse these hotspots and rank them in order to find the best hotspots for the upstream investment. These countries will be analysed based on four factors which are amount of **resource potential, fiscal terms, accessibility and country risk**.

2.1 Reasons for Hotspots Emergence

2.1.1 Increase in oil and gas demand

There are reasons behind the emergence of these new exploration areas. The first reason is due to the **increase in oil and gas demand** across the world. According to the data released by Wood Mackenzie in 2014, the oil and gas demand in 2030 will be 13000 mmboe and 8000 mmboe respectively. In comparison with year 2000 level, the demand for oil and gas has increased by 5000 mmboe and 7000 mmboe separately. This rapid increase in oil and gas demand has triggered the emergence of these new exploration hotspots. Extra amount of oil and gas are needed to meet the demand set by the market.

Table 2: Oil and gas demand in 2000 and 2030.

	Oil (mmboe)	Gas (mmboe)
2000	**8000**	**1000**
2030	**13000**	**8000**

2.1.2 Arrest the decline from mature fields

Other than that, **the production has started to decline especially in mature fields** across the world. For example, in the North Sea, the combined production of Denmark, Norway and the UK, have able to counter the decline in production in 2012 but it is starting to decrease again. Mexico is an interesting country but the production in the country is also declining in the past 8 years with most of the fields are starting to mature (Cantarel, San Andres and Tierra Blanca). The situation in Malaysia has been the same as in North Sea and Mexico where most of the fields are starting to mature and the production has been declined (Peak Oil Barrel, 2014).

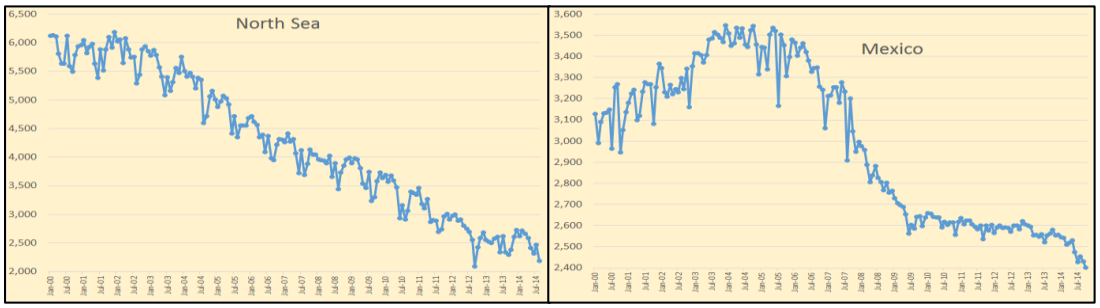

Figure 7: Production Profile of North Sea and Mexico

2.1.4 Create Market Stability

The last reason identified in this study is **the need of moving away from the traditional resource/production centre and create market stability**. According to the data provided by Wood Mackenzie, Middle East, North America and Russia represent almost 62% of global oil production in 2013. It shows that the global oil production has been dominated by these three main regions. It is important for the world to stop being too dependent on these countries and start new explorations in other areas in order to avoid the same situation that has been happening right now which is the sharp decline in oil and gas prices.

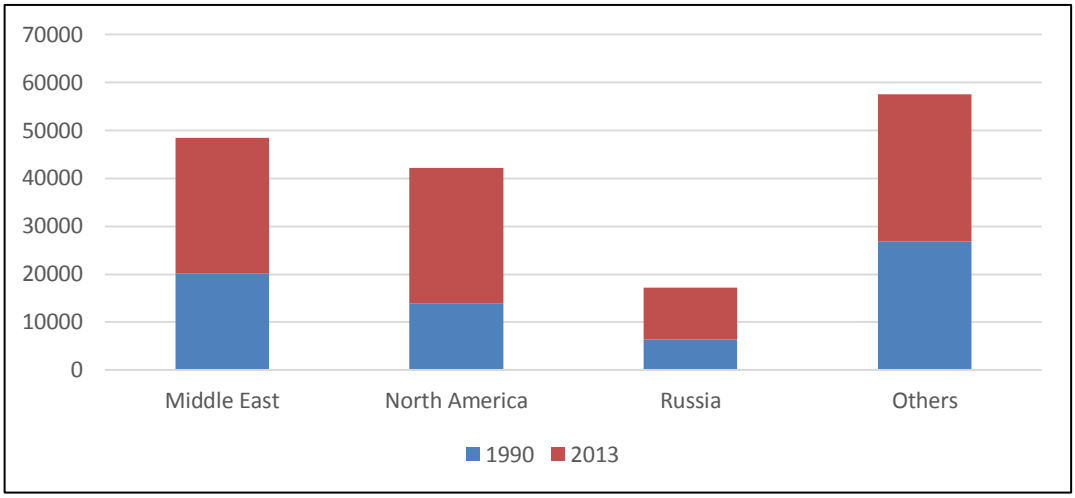

Figure 8: Global Oil Production, kb/d

2.1.3 Ensure energy security and to boost economy

Moreover, some countries especially in Africa are **open up their countries for the oil and gas exploration in order to boost the economy** of their countries. Sub-Saharan Africa for example has the most number of poor people in the world at 415.4 million people. Kenya, Sierra Leone, Cote d'Ivoire and Angola have been listed amongst the 40 poorest country in the world - UN Human Development Report. From the research done by World Bank in 2014, 50% of the world population that live below the poverty headcount ratio of $1.25 a day (PPP) are from Sub-Saharan Africa region. This statistic has proved that most of the poor people in the world are in the Sub-Saharan Africa Region. One of the way to boost the economy and move away from the poverty line is to develop their natural resources which are oil and gas.

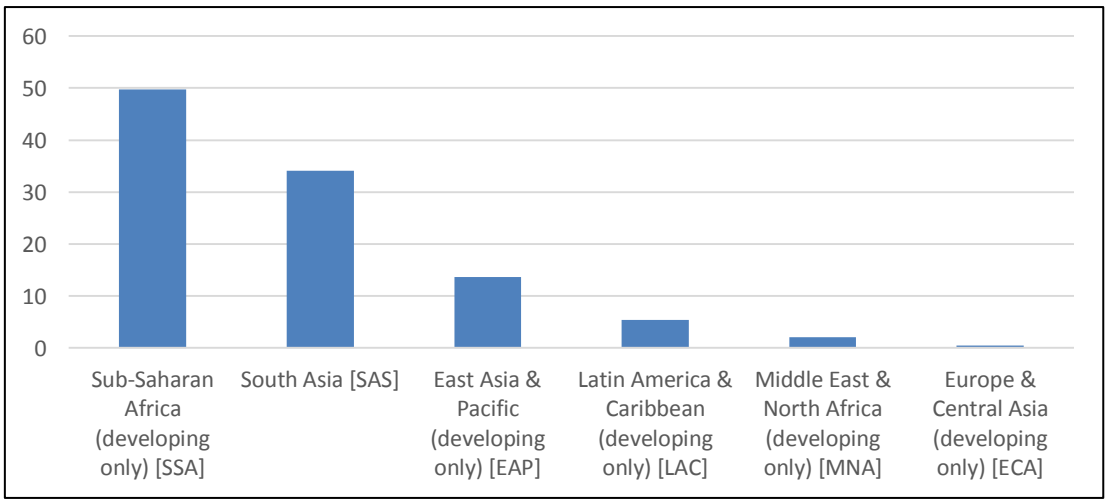

Figure 9: Poverty headcount ratio at $1.25 a day (PPP) (% of population)

2.2 Selected Components

There will be four main parameters covered throughout this report. The first component is about the **resource potential**. Under this section, the things that will be discussed are the amount of yet to discover reserve in each countries, the probability of discovery and production profile. The second component is the **accessibility** of each country will also be thoroughly discussed based on three factors which are availability of infrastructures, number of open/farm-in blocks and bid rounds. The third component is **fiscal**

terms. Under fiscal term, there are three sub-components which are distortion rate, government take and local content that will be used to analyse the fiscal regime of each country. The last component is the **country risk** consists of three sub-components which are political, economic and security risks.

2.2.1 Resource Potential

In analysing the prospect of oil and gas industry in any country, the amount and quality of oil and gas resources will always be a vital component according to Kaiser & Pulsipher (2006), Thomas (2007), Fattouh & Darbouche (2010), Mainwaring (2013) and Wood Mackenzie (2014). Without a significant amount and quality oil and gas reserves, contractors will not be able to generate rate of return in desired time and no investment can take place. Resource is defined as the summation of the amount of hydrocarbon initially in place at a specific time, hydrocarbon that has been produced and estimation of the yet to discover hydrocarbons (Denney & Dennis, 2007). There are few type of resources identified.

Table 3: Definition of Resources

Type of resources	Definition
Discovered Resources	Total amount of hydrocarbon in place estimated at a specific time contain in known accumulations.
Undiscovered Resources	Total amount of hydrocarbon in place estimated at a specific time contain in unknown accumulations.

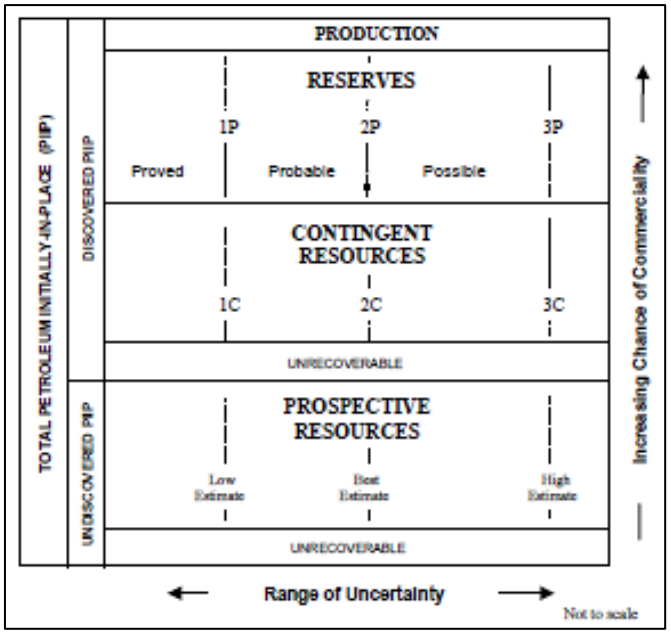

Figure 10: Resource Classification (Etherington & Ritter, 2007)

The amount of yet to find reserve or undiscovered resource is selected for this study in order to analyse the amount of oil and gas resources that are still available for the exploration to be made. According to SPE (2014), undiscovered resources is part of prospective resources. It is the amount of oil and gas reserves at a given date and time that are yet to be discovered by the explorers. Other than that, the amount of remaining oil and gas resources will be discussed in order to see whether those locations are oil prone or gas prone and also to determine the amount of added reserves for the past five years. It is important to know that it is much easier to commercialize oil than the gas because oil is tradable when compared to gas, does not need liquefaction process and does not need special tanks for storage. The quality of undiscovered resource is usually being supported by the probability of discovery and the production forecast. In order to come out with the sub-parameters in evaluating the resource potential, there are two main sources used which are IHS Country Ratings and Rankings and also India Benchmarking Report from Boston Consultant Group (BCG).

IHS Country Ratings and Rankings (2015) has highlighted several parameters to measure resource potential. The parameters used by them are as shown in figure below. There are four main criteria used and supported by few sub-parameters to evaluate the potential of the resource in each country. For reserve and production, the weightage given to oil are always 60% and the remaining percent is given to gas. Other than that, as for the success over

the last five years, the success rate (number of wells drilled) and reserve added are used to measure the attractiveness of the resources of each country.

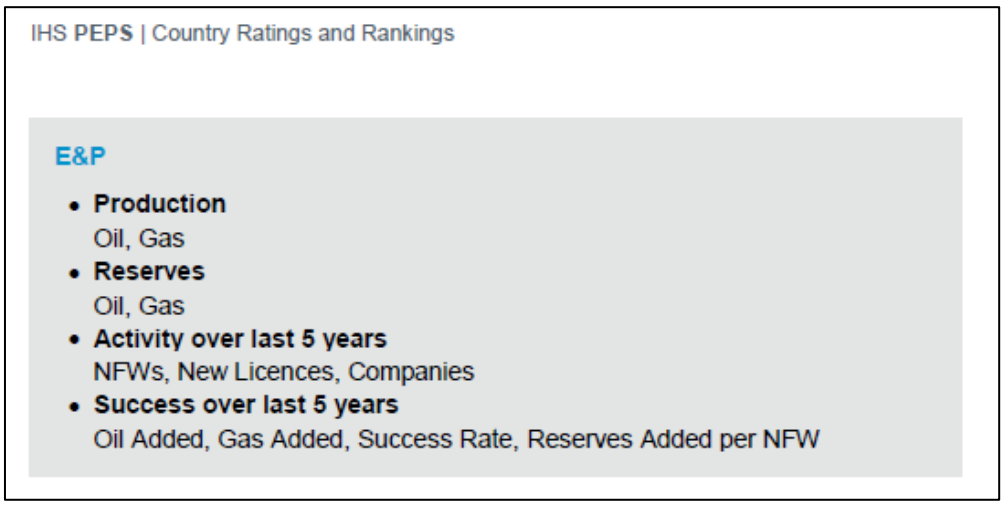

Figure 11: IHS Country Ratings and Rankings for Resources

As for the BCG, they focus on four main parameters which are total capex, yet to find reserves and also the increase in reserves and production. The summary of the rating criteria by BCG is as in the figure below.

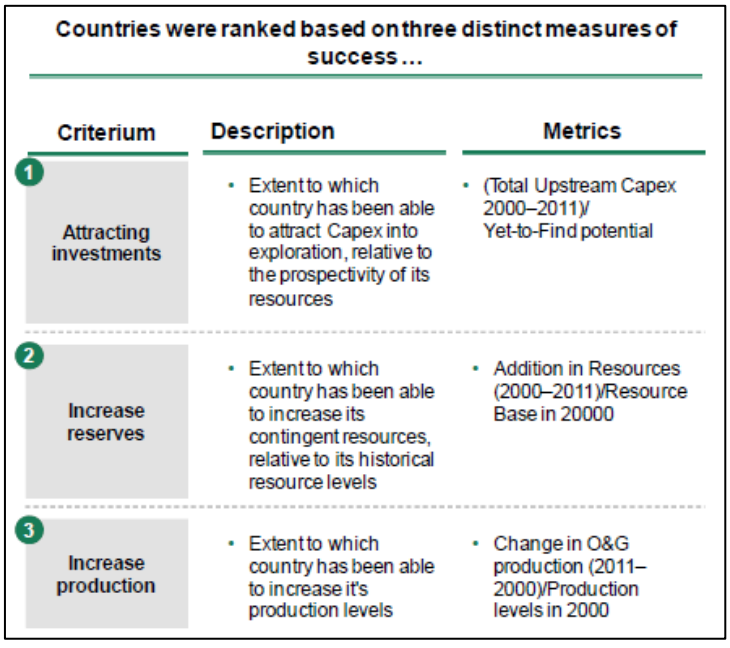

Figure 12: BCG Country Ratings and Rankings for Resources

The probability of the discovery is really important in the exploration strategy. High percentage of the dry zones will hinder the development of the oil and gas industry of a country. In this report, the probability of discovery will be calculated based on the CCOP (2000) and Malvic (2009). The screening criteria used to evaluate the probability of discovery by both study are summarized in the figures below. Basically, there are four main criteria used to calculate the probability of discovery. They are probability of reservoir, probability of trap, probability of charge and probability of retention.

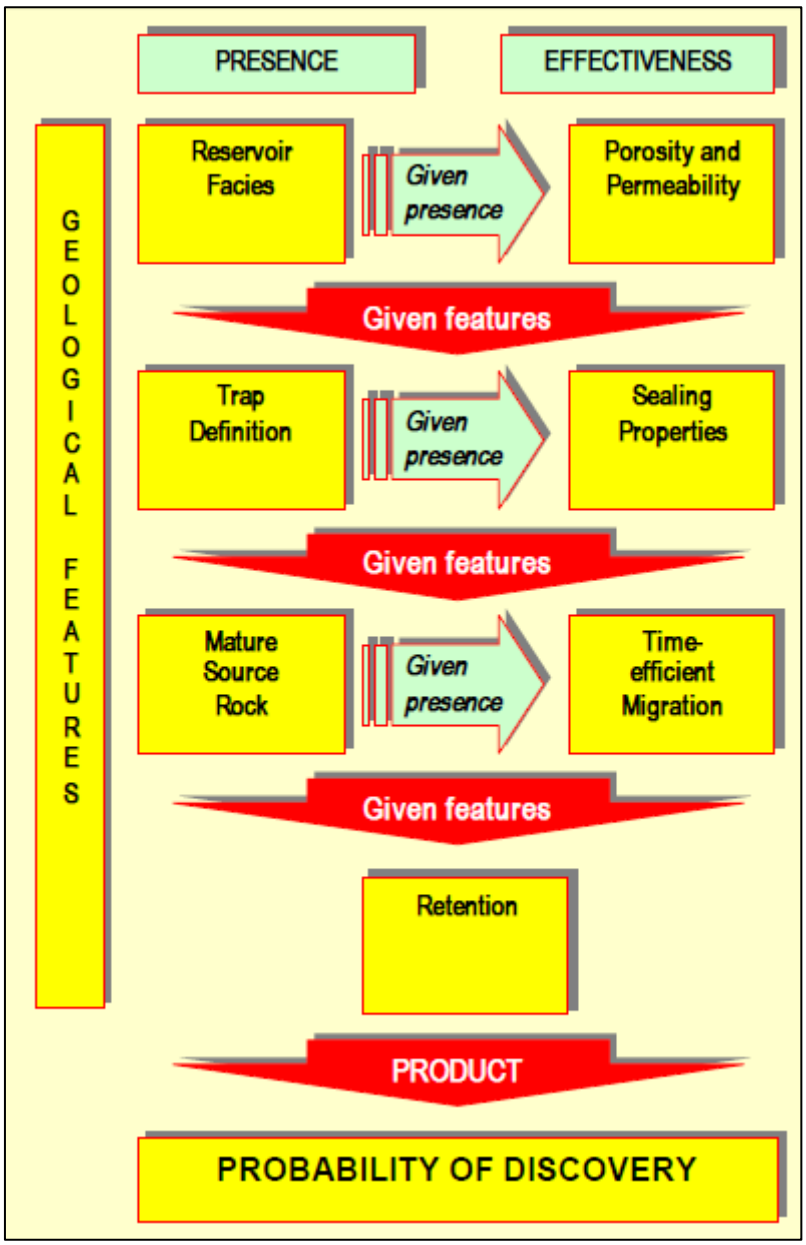

Figure 13: CCOP Geological Risk Assessment

Table 1. This is an example of relevant database prepared for the Bjelovar subdepression and can be mostly unchanged applied in all the Drava depression (after [2, 3])

TRAP	RESERVOIR	SOURCE ROCKS	MIGRATION	PRESERVATION OF HYDROCARBONS	
Structural	**Reservoir type**	**Source facies**	**HC shows**	**Reservoir pressure**	"p"
Anticline and **buried hill** linked to basement	**Sandstone**, clean and laterally extended; **Basement** granite, gneiss, gabbro; **Dolomites** with secondary porosity; Algae reefs with significant secondary porosity, due karsting or other subaerial processes exposure	**Kerogene** type I **and/or II**	**Production** of hydrocarbons	**Higher** than hydrostatic	1.00
Faulted anticline	**Sandstones,** rich in silt and clay; **Basement** with secondary porosity, limited extending; **Algae reefs**, filled with skeletal debris, mud and marine cements	**Kerogene** type **III**	Hydrocarbons **in traces**; **New gas** detected >10%	**Approximately** hydrostatic	0.75
Structural nose closed by fault	**Sandstone** including significant portion of silt/clay particles, limited extending;	**Favourable palaeo-facies** organic matter sedimentation	**Oil** determined **in cores** (luminescent analysis, core tests)	**Lower** than hydrostatic	0.50
Any "positive" faulted structure, margins are not firmly defined	**Basement rocks**, including low secondary porosity and limited extending	**Regionally known** source rock facies, but not proven at observed locality	**Oil** determined **in traces** (lumin. anal., core tests)		0.25
Undefined structural framework	Undefined reservoir type	Undefined source rock type	Hydrocarbon are not observed		0.05

Stratigraphic or combined	Porosity features	Maturity	Position of trap	Formation water	
Algae reef frim	**Primary** porosity **>15%** **Secondary** porosity **>5%**	Sediments are in **catagenesis phase** ("oil" or "wet" gas-	Trap is located in proven **migration distance**	**Still aquifer** of fold-waters	1.00
Sandstones, pinched out	**Primary** porosity **5-15%** **Secondary** porosity **1-5%**	Sediments are in **metagenesis phase**	Trap is located **between two source rocks** depocentres	**Active aquifer** of field-waters	0.75
Sediments changed by **diagenesis**	**Primary** porosity **<10** **Permeability** <1x10**(-3) micrometer**2	Sediments are in **early catagenesis phase**	**Short migation pathway** (<=10 km)	**Infiltrated aquifer** from adjacent formations	0.50
Abrupt changes of petrophysical properties (caly, different facies)	**Secondary** porosity **<1%**	Sediments are in **late diagenesis phase**	**Long migration pathway** (>10 km)	**Infiltrated aquifer** from surface	0.25
Undefined stratigraphic framework	Undefined porosity values	Undefined maturity level	Undefined source rocks		0.05

Quality of cap rock	Data sources	Timing	
Regional proven cap rock (seals, isolator)	Geochemical analysis on **cores and fluids**	Trap is **older than** matured **source** rocks	1.00
Rocks without reservoir properties	Analogy with **close located geochemical analyses**	**Trap** is **younger than** matured **source** rocks	0.75
Rocks permeable for gas (gas leakage)	**Thermal modeling** and calculation (e.g. Lopatin, Waples etc.)	**Relation** between trap and source rocks is **unknown**	0.50
Permeable rocks with locally **higher silt/clay content**	**Thermal modeling** at just a **few locations**		0.25
Undefined cap rock	Undefined data sources		0.05

Figure 14: Malvic Geological Risk Assessment

Quantity	TOC	S_1(mg HC/g rock)	S_2(mg HC/g rock)
Poor	<0.5	<0.5	<2.5
Fair	0.5-1	0.5-1	2.5-5.0
Good	1-2	1-2	5-10
Very Good	2-4	2-4	10-20
Excellent	>4	>4	>20
Quality	HI (mg HC/g TOC)	S2/S3	Kerogen Type
None	<50	<1	IV
Gas	50-200	1-5	III
Gas and Oil	200-300	5-10	II/III
Oil	300-600	10-15	II
Oil	>600	>15	I
Maturation	Ro (%)	Tmax (^{0}C)	TAI
Immature	0.2-0.6	<435	1.5-2.6
Early Mature	0.6-0.65	435-445	2.6-2.6
Peak Mature	0.65-0.9	445-450	2.7-2.9
Late Mature	0.9-1.35	450-470	2.9-3.3
Post Mature	>1.35	>470	>3.3

Figure 15: Garrey and Atta-Peters Geological Risk Assessment

From the parameters in these three reports, based on the data availability, this study will evaluate the probability of discovery based on the table shown below. There are four main parameters. The only difference are the sub-components used in evaluating the probability of discovery. Other than that, due to time constraint in developing this project, there will be only two basins evaluated for each country. The basins with most discovery in the country will be evaluated. Further discussions will be discussed in the methodology part of this report.

Table 4: Screening parameters for probability of discovery

Probability of Reservoir	**Probability of Trap**	**Probability of Charge**	**Probability of Retention**
Presence of reservoir facies - Depositional environment type.	Effective seal mechanism - Type of seal - Type of fault - Top suface - Bottom side	Effective source rock - Quality and quantity of source rock • Kerogen type. • TOC - Maturity • R_o • T_{max} - Assume sufficient volume.	- Geological events after accumulation.
Effective pore volume - Depth. - Porosity, permeability and water saturation.		Effective migration and timing - Timing. - Migration style.	

2.2.2 Accessibility

The second component of this study is about the accessibility. Bolton Consultant Group, in their India E&P assessment report has highlighted the importance of the accessibility for an upstream evaluation. They have used number of blocks and bid rounds as the evaluation parameters in the upstream environment assessment as shown in the figure below. Under accessibility of this project, the minor components that are going to be analysed are **infrastructures**, **number of open blocks and farm-in opportunities blocks**. Other than that, the **bid rounds** in selected countries will also be monitored.

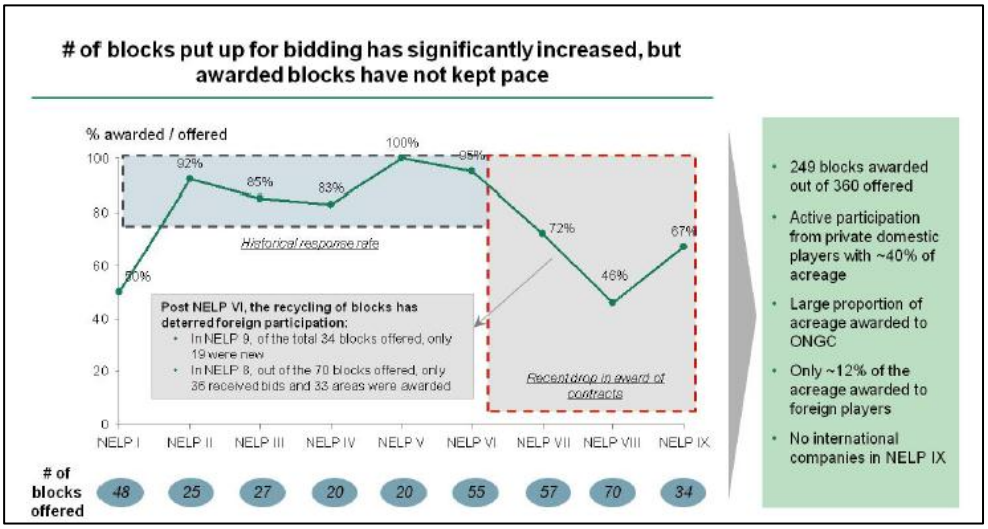

Figure 16: BCG accessibility assessment

Infrastructures play an important role in determining the attractiveness of a country. IHS in the Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits (2013) has discussed on the importance of the oil and gas infrastructure on the economics of a country. The economic stability is one of the importance factor in defining the attractiveness of a country. It will be further discussed in the country risk part under the economic section. The infrastructures mean the facilities required for the oil and gas industry to work such as pipelines, storage facilities and transportation routes. Without these facilities, the hydrocarbon found within a country will be difficult to be developed. Its attractiveness as a whole will be dropped in the eyes of the investors since it will require them to build all the facilities first before they can develop the resources in a country, assuming the country has vast amount of oil and gas reserves. It will require a lot of money for the investors to commercialize the reserves especially if it is gas. Gas needs a combination

of vast reserves and good facilities especially in transportation side for the investment to really be profitable.

Block is defined as an area consists of separate structure and proven reserves (SPE, 2010). According to the oilvoice.com, the definition of farm-in is the process whereby a company joins other companies in order to explore the blocks in an exploration activity. Availability of blocks for bidding could play an important role in determining the attractiveness of the hotspot. A good number of open and farm-in opportunities blocks are required, especially by the minor oil and gas companies in order to avoid high level of competitiveness during the bidding process. Wood Mackenzie and IHS for example have highlighted the importance of the blocks availability in their analysis. According to the data provided by IHS, currently there are about 2598 and 1714 of open and farm-in opportunities blocks available across the world.

The **bid rounds** is an event held by any country for oil and gas firm to bid for the available blocks. Companies have to go through bid rounds in order to get the permission to do the exploration activities in the countries they are interested. Usually, companies have to wait for the country to announce the bidding date in order to start bidding for the acreages/blocks. For some countries, contractors/companies have to ask for the availability of the bid rounds since they do not do the announcement publicly. Currently, as of April 14th 2015, there are about 25 countries who are holding bid rounds. Most of the bid rounds happening now are coming from the Sub-Saharan Africa, Far East and Australasia regions (IHS, 2015).

2.2.3 Fiscal Terms

The next component that will be discussed in this project is the fiscal regime. Fiscal terms is defined as the legislative tax, fiscal elements and contractual that have been used for the purpose of doing exploration and production activities in any country (Omowumi, 2001). Fiscal term is always been used by the government to fully exploit the profit made in any exploration and production activities from the taxes, bonuses and etc. (Omowumi, 2001 and Young & Lasswell, 2013). It is used to attract the investors into a country by providing an interesting terms for the investors (Blake & Roberts, 2006). Fiscal terms is mainly used to divide the profit made from the oil and gas produced between contractors and government (Dongkun & Na, 2010).

Basically, there are two type of petroleum fiscal regimes. They are known as contractual and concession/royalty tax systems. There are some other type of fiscal terms under contractual system. They are Purchase Contract, Service Contract and Production Sharing Contract. The figure below shows the type of fiscal regimes available throughout the world.

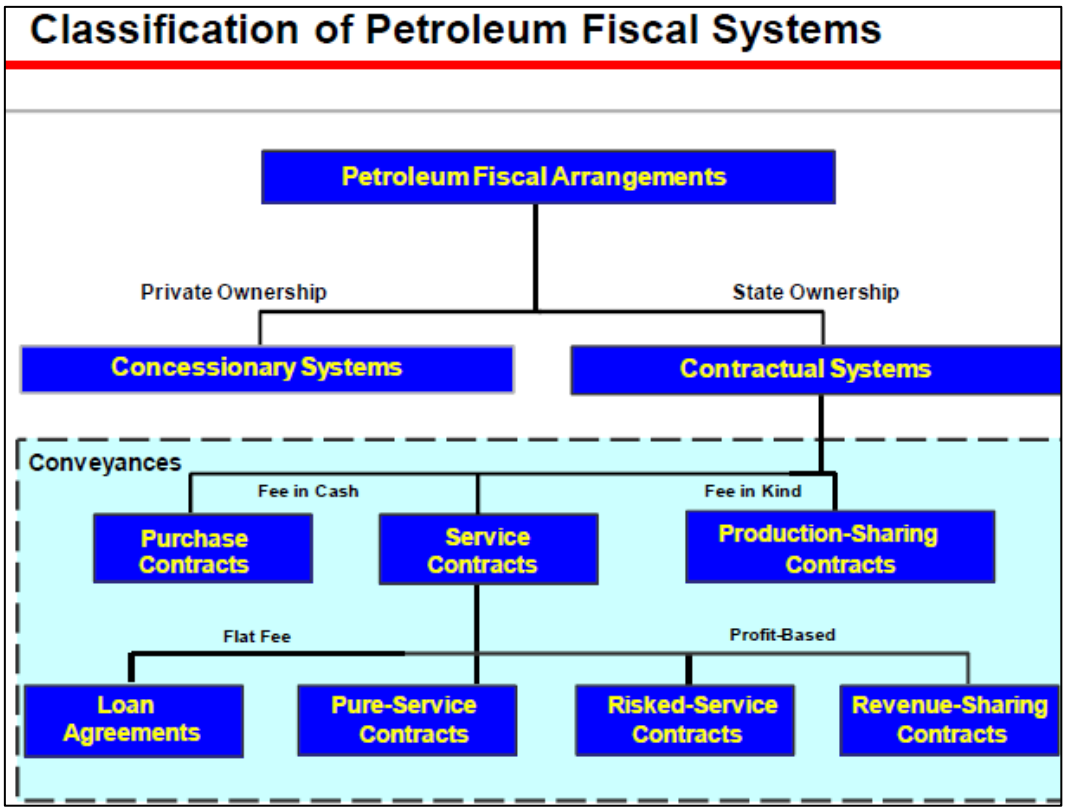

Figure 17: Type of Fiscal Regime

There are few differences between these two types of fiscal regime. But the most obvious one is about the ownership of the hydrocarbon. Table below has highlighted the differences between these two fiscal regimes. The degree of hydrocarbon ownership and reserves recognition is different for each type of agreement as shown in Figure.

Table 5: Differences between Contractual and Concession System

	Contractual System	**Concession System**
Ownership	Government	Contractor
Risk	Contractor	Contractor

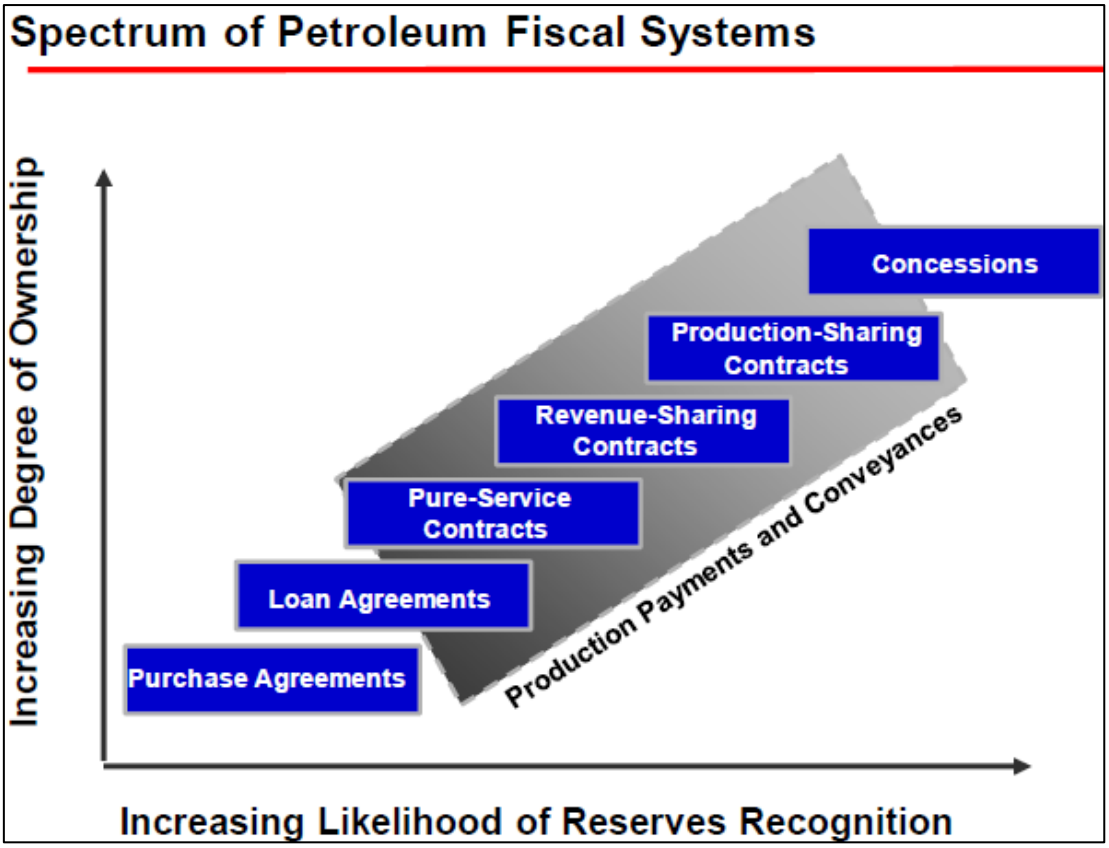

Figure 18: Spectrum of Petroleum Fiscal Systems

2.2.2.1 Concession Agreement

In the 1950s, concession agreement is the most popular agreement used by contractors and governments for the exploration and production activities. (Higgins, 1992 and Young & McMichael, 2002). Under concession agreement, company will be awarded with a contract to explore and produce hydrocarbon from an area within a specific time. If the exploration is successful, company is required to pay some money to the government in the form of rentals, royalties and taxes. The title of the hydrocarbon is belong to the company/contractors (Omowumi, 2001 and Young & Lasswell, 2013).

2.2.2.2 Production Sharing Contract

Production Sharing Contract (PSC) is one of the agreements categorized under the Contractual type. PSC has been introduced by Indonesia in 1966 (Higgins, 1992). The ownership of the hydrocarbon will always retain with the host government (Young & Lasswell, 2013). The risks of the activities will be a responsible for the contractor/company (Omowumi, 2001). However, contractor will be allowed to get back their money from the production within specific limits and terms. Other than

that, contractor will also be awarded with the prescribed share of hydrocarbon during the production stage (Young & Lasswell, 2013 and Young & McMichael, 2002).

2.2.2.3 Service Contract

Service contract was introduced in Myanmar back in 1973. This agreement was created after a detail review on the Production Sharing Contract of Indonesia (Higgins, 1992). This agreement is almost the same as the PSC except for the operatorship. In PSC, company will remain as the operator but in Service agreement, national oil company will be the operator of the exploration and production area. This type of agreement is not popular among the contractors as it allows the government to have such a big control in the E&P activities (Higgins, 1992).

2.2.2.4 Purchase Contract

In this agreement, a price will be agreed between contractors and governments for the purchasing of the specific amount of oil and gas. The seller will bear all the risks related to the technical and market risks. However, reserves and resources will not be acknowledged by the *Resources Entitlement and Recognition of the Guidelines for Application of the Petroleum Resources Management System* (PRSM) under this kind of agreement (Young & Lasswell, 2013).

For this report, there will be three sub-components covered under the fiscal terms. They are **tax distortion, government take and local content requirement**. Tax distortion is a method that is usually being used in order to evaluate the fiscal regime of a country. It has been used by (Lund, 1987) and (Lund 1990) in order to do inspection on the fiscal regime. Blake & Roberts (2006) has highlighted the importance of the local content requirement in analysing the fiscal regime of a country. Other than that, government take is the most popular parameter that has been used to analyse the fiscal terms of a country. There are several parameters that have been used in calculating government take - royalties, profit oil split, taxes and government participation (Rutledge & Wright, 1998 and Dongkun & Na, 2010). The analysis will focus on fiscal terms in deep-water areas. This is because most of the current discoveries made are either in deep-water or ultra-deep-water/pre-salt regions (IHS, 2014).

2.2.4 Country Risk

Another component that is important for the analysis of the hotspots is country risks. For this report, the methodology used will be based on the assessment done by IHS. IHS uses several parameters to assess the risks associated with a country. The parameters that have been used in their assessment are shown in the figure below. Under the country risk for this report, there are only three of the parameters are chosen. They are political, economic and security. The rating for each of the sub-components are provided by IHS. The full scenarios that happen in the selected countries will be discussed throughout this study. The main thing that will be looked at these components is the stability of the country in developing oil and gas industry.

Figure 19: IHS Country Risk Assessment

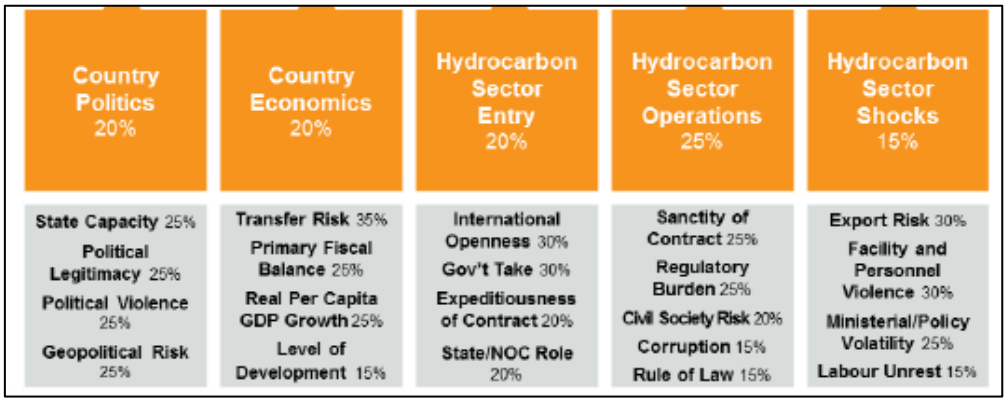

Figure 20: IHS Country Risk Assessment - Rating

2.2.2.1 Political

Political stability is important in order to make sure that there will be no changes in agreements or other things in the future. This is because whenever there is a change of government, the terms and the laws will always be modified to suit the style of the new government. According (Wyk, Dahmer, & Custy, 2004), policies of the government and instability are the main factors under political risk. Other than that, minimizing the political problems can also boost FDI (Kenisarin & Speed, 2008). It is found that the legal stability and framework of a government will affect the foreign direct investment (FDI) of a country. Furthermore, civil wars and unrest is also going to have effect on the FDI (Groh & Wich, 2009). For this assessment, there will be 2 minor components that are going to be discussed which are violence and geopolitics risks.

2.2.2.2 Economic

As for economic part, it is vital to make sure that the investments put by companies can generate profit for them in the future. Wyk, Dahmer, & Custy, 2004, identified country's macro-economy as the main aspect to determine the strength of the economy. A country with strong economic growth is good for investment. GDP growth of a country is really important in determine the FDI (Groh & Wich, 2009). But for the developing countries, rapid industrial growth and expanding domestic market are two aspects that are vital to make sure the economy of a country remains strong. As for economic part, the minor components will be GDP per capita and level of development that will be the focus of discussion.

2.2.2.3 Security

The security is also an important component to make sure that it is save to have a business in a country. Without business security, it is hard to know the level of safety a country has. IHS has highlighted the important of the security risk in their Country Reports for each country that is available for oil and gas investment. In assessing the security of a country, there will be three minor components to be discussed in detail. They are safety, labour unrest and corruption level.

CHAPTER 3

METHODOLOGY

3.1 Project Phases and Workflow

This study consists of four phases. The flow is shown in Figure 1 below.

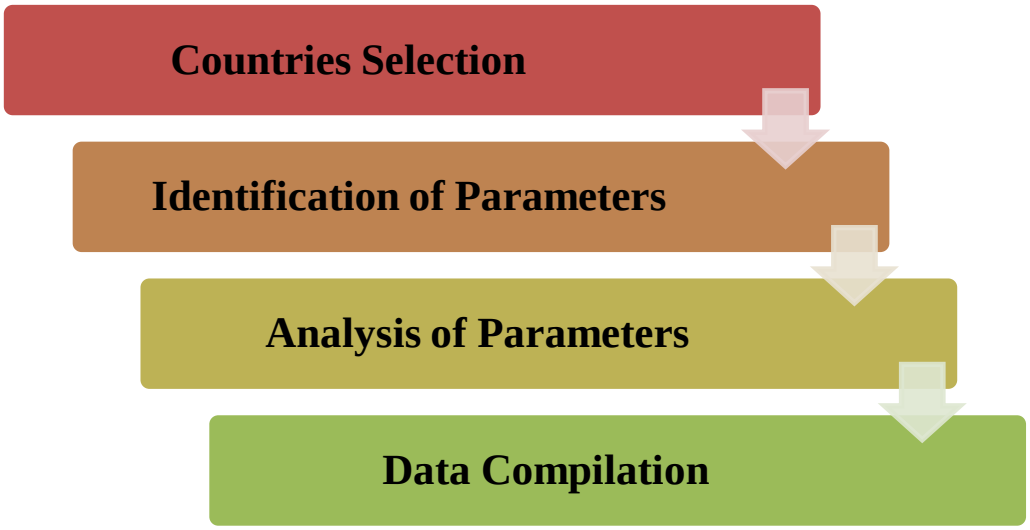

Figure 21: Project Workflow

Phase 1: Countries Selection

There are eight countries selected for this study. The countries are chosen based on some factors. The factors are:

- Theory of West African Transform Margin, East African Rift Play and West African Pre-Salt.
- Mexico opening and lifted sanction in Myanmar.
- Amount of discoveries made for the past five years.

Phase 2: Identification of Parameters

Phase 2 of this study involves identification of parameters. In order to evaluate the selected countries for this study, four parameters have been identified. The parameters are:

- Resource Potential

  There are two main components that will be used as the indicator to determine the quality of resources of a country. The first indicator is the amount of yet to find resources of the country. The second indicator is the probability of geological success. The amount of oil and gas reserves from the selected countries will be compared to Malaysia. Malaysia is one the significant oil and gas producers. They are listed in the top 10 of world largest oil and gas exports countries. The amount of reserve owned by a country is important since it will be the parameter that will determine whether investors are willing to invest their money or not. The probability of success will be calculated by choosing the data from the two most prolific basin in the country. It is important since it will also determine the probability of exploration success. This report will provide a guideline for petroleum prospect risk assessment based on the CCOP (2000) and Malvic (2009).

- Accessibility

  The second component is the accessibility of a country. The accessibility will be assessed based on three sub-components which are availability of infrastructures, number of open/farm-in opportunities blocks and the bid rounds. Number of blocks available for the investors to bid will be assessed together with the availability of the

bid rounds in those countries. The presence of in-place infrastructure will also be assessed in this report.

- Fiscal Terms

  The third component under this project is the fiscal terms offered by each country. The most important data under the fiscal regime are amount of bonuses, royalty, contractor's take, taxes and state participation in each project. The main component is government's take as it will be the most vital to determine the amount of profit to be generated by the investors in the future. Other than that, the local content of a country will also be evaluated. Signature bonus will also represents a small percentage under fiscal terms for this study.

- Country Risk

  The last parameter, country risk, there will be three sub-components used to analyse the stability in each country. Political, Economic and Security risks are chosen and they are rated in a range from 1-5. 1 and 5 represents the maximum and minimum risks respectively. The rating is provided by IHS. However, the political, economic and security of the selected countries will be discussed in details throughout this report.

Phase 3: Analysis of Parameters

Stage 3 of this study is the analysis of parameters where the selected components are evaluated. Each main component is given the weightage for the calculation of the scores. The figure below shows how each of the components have been rated. The rating value is ranging from 1 to 5. 1 and 5 represent minimum and maximum rating respectively.

15 hotspots have been chosen in order to create the rating criteria. For example, countries are sorted from smallest to largest based on the amount of yet to find reserves. The minimum and maximum have been selected and this range has been used as an indicator for the rating value criteria. The same method is used for fiscal terms and two other parameters in producing the rating criteria. After each of the sub-component has been rated, the rated values will be used to calculate the scores for each of the component based on the weightage given as shown in the table below.

Table 6: Reserves of hotspots countries

Country	Oil, mmboe	Country	Gas, mmcf
Guyana	45.75861251	Guyana	98.96324175
Suriname	45.75861251	Suriname	98.96324175
Ghana	59.83912832	Ghana	506.568108
Cote d'Ivoire	122.9348078	Cote d'Ivoire	1040.704549
Morocco	125.2525687	Morocco	1351.156527
Malaysia	139.6349425	Malaysia	1679.620352
Australia	149.2780069	Angola	2981.348987
Argentina	490.8668047	Kenya	3090.281599
Tanzania	954.0274832	Australia	6427.812915
Kenya	1343.796018	Gabon	7552.519841
Myanmar	2292.441384	Argentina	10338.27341
Angola	2584.459582	Myanmar	16180.51352
Mozambique	2920.553437	Tanzania	24176.51267
Gabon	3224.435768	Mexico	27820.53112
Mexico	3972.533153	Mozambique	45587.20602
Brazil	4463.196411	Brazil	85405.0006
Min	**45.75861251**	**Min**	**98.96324175**
Max	**4463.196411**	**Max**	**85405.0006**

The range is selected based on the minimum and maximum values generated.

a) Resource Potential Screening Criteria

Table 7: Rating Criteria for amount of resources

Sub-parameter	Type of hydrocarbon		Rating
Amount of yet to find resources	Oil	Gas	
	>3 Bn barrel	>28 tcf	5
	2-2.99 Bn barrel	10-27.9 tcf	4
	0.5-1.99 Bn barrel	3-9.9tcf	3
	<0.5 Bn barrel	<3 tcf	2
Probability of discovery	>0.5		5
	0.3-0.49		4
	0.2-0.29		3
	0.1-0.10		2
	<0.1		1

In calculating the **probability of the discovery**, a screening parameter have been formed from CCOP (2000), Malvic (2009) and (Garray & Atta-Peters, 2014). The criteria is as follow:

I. Probability of reservoir

- Presence of reservoir facies

Depositional Environment	Sub-Depositional Environment	Probability
Marine	Shallow marine blanket	0.9-1.0
	Coastal, deltaic, tidal	0.8-1.0
	Submarine fan	0.7-0.8
	Carbonates	0.8-1.0
Continental/Terrestrial	Lacustrine deltaic	0.7-0.9
	Alluvial fan, braided stream, meandering chan	0.7-0.9
	Eolian	0.8-1.0
Others	Fractured basement	0.4-0.6
	Fractured, porous lava	0.4-0.6

- Effective pore volume

Depth, km	Porosity	Permeability	Probability
1-3	>15%	>1000	0.8-1.0
3-4	5%-15%	1-1000	0.7-0.9
>4	<10%	<0.01	0.5

II. Probability of Trap

- Effective seal mechanism

Seal mechanism and quality	Top surface	Bottom side	Structural style	Very good	good	acceptable	poor
Simple seal	Conformable	N/A	Anticline, buried highs, build ups and faulted str.	0.9-1.0	0.8-1.0	0.6-0.8	0.4-0.6
	Unconformable	N/A	Faulted structures	0.8-0.9	0.7-0.8	0.5-0.7	0.3-0.5
Combined seal	Conformable	Unconformable	On lap, low stand wedge	0.5-0.7	0.4-0.5	0.3-0.4	0.1-0.3
	Conformable	Faults	Downfaulted structure	0.6-0.8	0.5-0.6	0.3-0.5	0.1-0.3
	Conformable	Facies shift	Shale out	0.6-0.8	0.5-0.7	0.4-0.6	0.1-0.3
	Unconformable	Conformable	Subcrop structures	0.4-0.5	0.3-0.5	0.2-0.4	0.1-0.3

III. Probability of Charge

- Quality and Maturity of Source Rock

Main component	Sub-component		Probability
Quality/Quantity of source rock	TOC,%	>5	0.8-1.0
		2-5	0.7-0.8
		1-2	0.6-0.7
		0.5-1	0.5-0.6
		<0.5	0.5
	Kerogen type	I or/and II	1
		III	0.75
		Others	0.5
Maturity of source rock	R_o	0.5-2	0.8-1.0
		2-2.5	0.7-0.8
		<0.5	0.5
	T_{max}, ℃	435-455	0.8-1.0
		456-465	0.7-0.8
		<435	0.5-0.6

- Migration type and Timing

Main component	Sub-component	Probability
Migration type	Lateral	0.8-1.0
	Vertical	0.6-0.7
	Others/Unknown	0.5
Timing	Trap is older than matured source rock	1.00
	Trap is younger than matured source rock	0.75
	No relationship between trap and source rock	0.50

IV. Probability of Retention

Geological process after accumulation		Probability
No late activities	No tectonic activities	0.9-1.0
	Shallow trap, possible biodegradation	0.8-0.9
Erosion	Trap in connection to generating source	0.7-0.9
	Trap not connected to generating source	0.5-0.8
Uplift and tilting	Form, volume and top point are not changing	0.7-0.9
	Form, volume and top point are changing	0.5-0.6
Reactivated faults	Compression	0.5-0.7
	Tension	0.4-0.6

Monte Carlo Simulation

To reduce the risks and uncertainties of the data, the data that are in the form of values will be evaluated using Monte Carlo simulation with 5000 iterations in order to determine and predict the most likely outcome of the value if a well is drilled throughout the basin in the future. The data involved are porosity, permeability and the depth of the reservoir. It is also important to note that the data used in this report are data from the wells that have been drilled in the selected basins.

According to Rao (2010), Monte Carlo is a mathematical technique used for risk analysis especially when it involves quantitative analysis and decision making. Monte Carlo works by using the probability distribution in developing a model of possible results. Depending on the requirement, Monte Carlo simulation could involve thousands of iterations before it generates the results. RiskAMP software will be used in order to run the simulation for this project.

There are a few type of distributions usually used by for risk and uncertainty analysis. The distributions are normal, log normal, PERT, uniform and triangular. The difference between these distributions as has been screened from Rees (2009), Lumenaut (2008) and Rao (2010) are clearly discussed as shown in the table below. In evaluating the porosity, permeability and other components, the log normal distribution is chosen because these parameters are the same parameters that have been used for estimating oil reserves.

Table 8: Type of Distributions

Distribution	Description	Application
Normal	Value close to the mean is the most likely to occur.	Energy prices
Log Normal	Positively skewed and will not go below zero.	Oil reserves
Uniform	The chance of occurring is the same for all values.	Drilling cost
Triangular	Value that is close to the most likely value has the most chance of occurring.	Cash flow

Monte Carlo using RiskAMP – Log Normal Distribution

Step 1: Select a population for the analysis. For example the porosity values from each basin.

Step 2: Calculate mean and standard deviation of the population.

Step 3: Select the Log-Normal distribution from "Insert Distribution".

Step 4: Run the simulation using "Histogram and Chart Wizard". Specify the number of desired iterations.

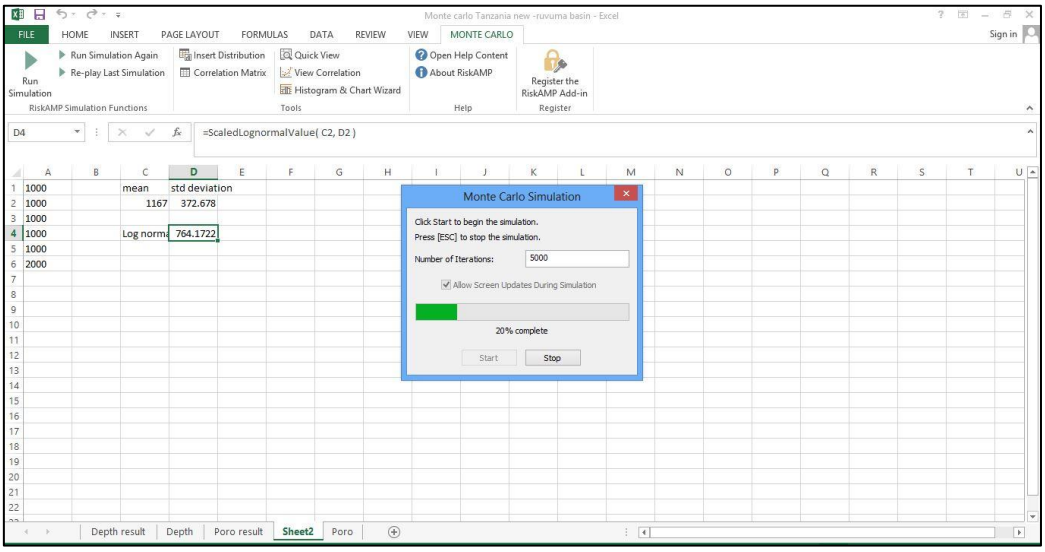

Figure 22: Running the simulation

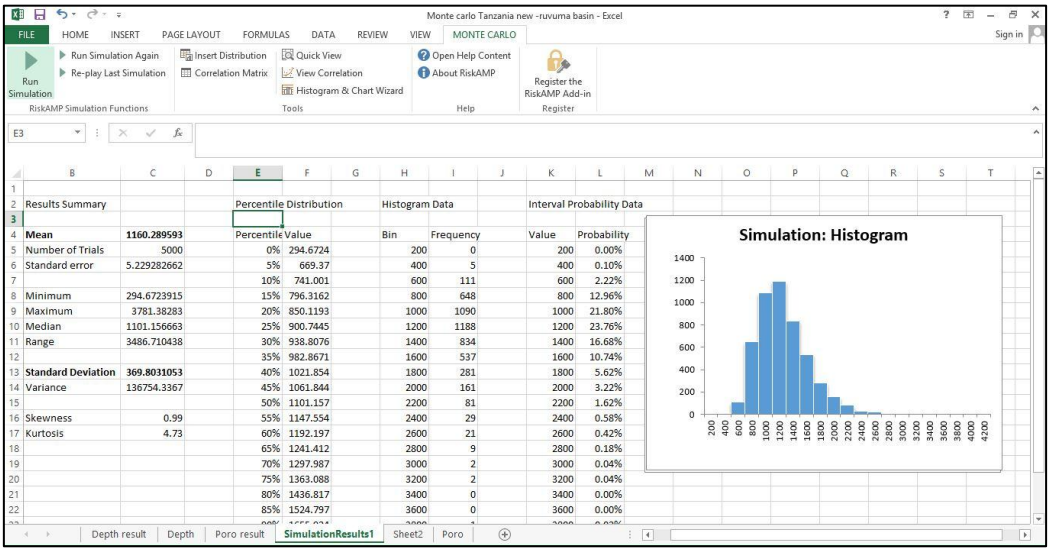

Figure 23: Result of the simulation

b) Accessibility Screening Criteria.

Table 9: Rating Criteria for accessibility

Sub-Parameter	Criteria	Rating
No. of blocks (Open and farm-in)	>50	5
	30-49	4
	20-39	3
	10-19	2
	<10	1
Bid rounds	**Open/Announced**: There is/are bid round(s) to be held in the near future by the country.	5
	Unconfirmed: The bid round(s) is/are yet to be confirmed by the country but there are possibilities that the round will be held.	3
	Closed: The bid round(s) is/are closed and there are huge uncertainties on whether the country will conduct a bid round in near future.	1
Infrastructure	- Great infrastructure in terms of pipelines and storage facilities. - Required little addition for the infrastructure for the transportation and storage process.	5
	- Have adequate infrastructure for the storage and transportation of hydrocarbon. - Required additional transportation and storage facilities for a better	3
	- Have poor infrastructure for the storage and transportation of hydrocarbon. - Required great addition to the current infrastructure for the transportation and storage of hydrocarbon.	1

c) Fiscal Terms

Under fiscal terms, there will be two technical analysis involved which are calculation of government take and the tax distortion. Both of the calculation is further discussed below.

Government take of PSC Model

In order to calculate the government take of a country, there are few parameters need to be considered. First of all, the net cash flow has to be calculated. The calculation of net cash flow is based on the consideration shown in the table below:

Table 10: Different case study for calculation of net cash flow

Field Reserve Sizes	Reserve	Oil Price
Very Small	10	40
		60
		80
		100
		120
Small	25	40
		60
		80
		100
		120
Medium	50	40
		60
		80
		100
		120
Large	100	40
		60
		80
		100
		120
Very Large	250	40
		60
		80
		100
		120

The formula to calculate the after tax net cash flow is as follow:

NCF_t = PtQt – ROY_t – CAPEXt – OPEXt – BONUSt – POGt – TAXt- OTHERt

Where,

POGt = Government profit oil in year t

PtQt = Gross Revenue

CAPEXt = Capital Expenditure in year t

OPEXt = Operating Expenditure in year t

BONUSt = Bonus in year t

TAXt = Tax in year t

OTHERt = Special Petroleum Tax in year t

After the calculation of net cash flow, the other parameter needs to be considered is the total cost and profit of the project. The formula is shown below:

TCt = CAPEXt + OPEXt

The formula to calculate the contractor and government take is as follows:

CTt = GRt – TCt – BONUSt - ROYt – BONUSt – POGt – TAXt

GTt = BONUSt + ROYt + BONUSt + POGt + TAXt

The percentage of the government take can be calculated as below:

Government take (%) = $\frac{\text{GTt}}{\text{TPt}}$

Lastly, to find the average government take of a country, a graph of government take vs. NPV will be created. It will have a progressive shape since all of the fiscal regime under this study is from PSC model. When the graph starts to stabilise, it indicates the average government take of a country.

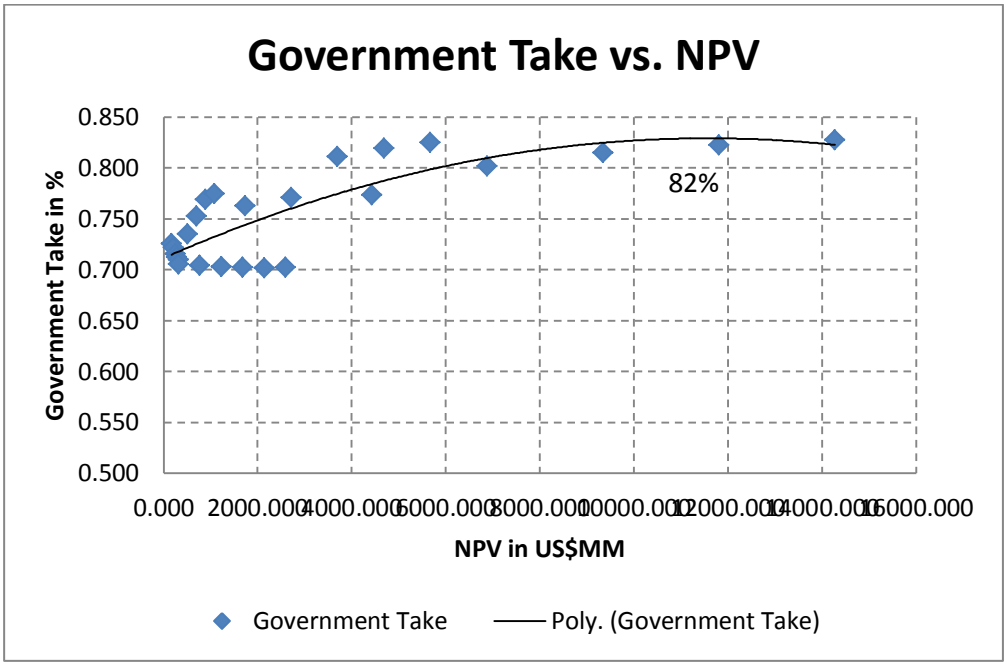

Figure 23: Government take vs. contractor NPV

Tax Distortion:

The formula to calculate the tax distortion is quite simple as compared to the government take. The formula is:

$$Tax\ distortion\ index = \frac{Net\ present\ value\ with\ taxes}{Net\ present\ value\ without\ taxes}$$

From the formula, it can be seen that with higher value of tax distortion, the tax implied by the government is actually low. So, it can be conclude that the higher the tax distortion index, the better it is.

d) Country Risk Screening Criteria

For the country risk screening, this project will use the data from IHS. The methodology in assessing the risk and applying the ratings are as being done by IHS. They evaluated the country risk using few parameters such as political, economic, security and business environment (legal and operational). The rating criteria used are as shown below.

In collecting the information for the risk assessment of a country, they:

- Conducted an interview with operators in the host country.
- Collecting information from political, economic and industry experts.

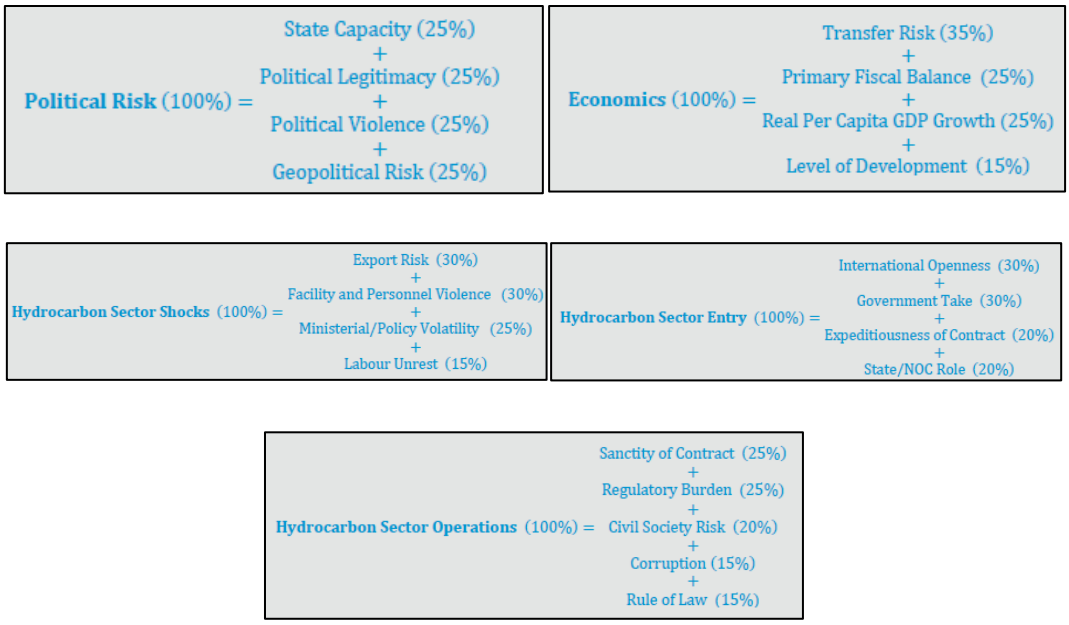

Figure 24: IHS Petroleum Risk Rating Criteria

But for this project, there will be only three sub-parameters chosen due to time constraints. The parameters are politics, economics and security risks of country.

Pairwise Comparison:

Pairwise comparison matrix is a type of tool used to determine the weightage of a set of criteria based on their degree of importance. Using this method, it enables the decision maker to rank a selected criteria with respect to the other criteria. Without a good weighted-matrix system, a systematic and reliable rating criteria is difficult to create.

Pairwise comparison method is constructed based on the framework of Analytic Hierarchy Process (AHP). Basically, there are only two simple steps required for this method. The steps are completion of the pairwise comparison matrix and calculating the criteria weights. According to (Bozoki, Fulop, & Poesz, 2011) and (Theo , 2010), using a pairwise comparison to evaluate *n* items, the decision makers are the one who determines how much important of item *a* than item *b*. A matrix is known as pairwise comparison matrix if the values are always positive and reciprocal.

The calculation of the weightage is shown below.

Table 23: Scoring Guide for Pairwise Comparison by Temesi (2006)

Score	Definition
10	The issue at hand is of the highest possible order of affirmation and is much more important than the other issue.
8	The issue is strongly important for the owner in choosing a delivery method and is absolutely more important compared to the other issue.
6	The issue is more important for the owner than the other one.
4	The issue is slightly more important to the owner.
2	The issue is not practically more important but yet slightly more effective while selecting a delivery method.
9,7,5,3,1	Intermediate values between two adjacent judgments.

Overall:

	Resources	Accessibility	Fiscal Terms	Country Risk	Total	Weightage
Resource	1	2	3	4	10	45
Accessibility	1/2	1	2	3	6.5	29
Fiscal Terms	1/3	1/2	1	2	3.83	17
Country Risk	1/4	1/3	1/2	1	2.08	9
				Total	22.41	100

Resource Potential:

	Amount of YTF reserves	Probability of discovery	Total	Weightage
Amount of YTF reserves	1	1	2	50
Probability of discovery	1	1	2	50
			4	100

Accessibility:

	Infrastructure	Number of blocks	Bid rounds	Total	Weightage
Infrastructure	1	2	2	4	40
Number of blocks	1/2	1	1	3	30
Bid rounds	1/2	1	1	3	30
			Total	10	100

Fiscal Terms:

	Distortion rate	Government take	Local Content	Total	Weightage
Distortion rate	1	1	2	4	40
Government take	1	1	2	4	40
Local Content	1/2	1/2	1	2	20
			Total	10	100

Country Risk:

	Political	Economic	Security	Total	Weightage
Political	1	1	2	4	40
Economic	1	1	2	4	40
Security	1/2	1/2	1	2	20
			Total	10	100

Table 10: Summary of the weightage of the components

Component	Weightage	Sub-component	Weightage
Resource potential	45%	YTF reserves	22.5%
		Probability of discovery	22.5%
Accessibility	29%	Infrastructure	11.6%
		Number of blocks	8.7%
		Bid rounds	8.7%
Fiscal terms	17%	Distortion rate	6.8%
		Progressive/Regressive	6.8%
		Local Content requirement	3.4%
Country risk	9%	Political	3.6%
		Economics	3.6%
		Security	1.8%

Finally, the total score for each county is going to be evaluated based on the formula given below:

$$Total\ Score = (RT_{Res} \times 0.225) + (RT_{PD} \times 0.225) + (RT_{INF} \times 0.116) + (RT_{BLO} \times 0.087) + (RT_{BR} \times 0.087) + (RT_{DR} \times 0.068) + (RT_{GT} \times 0.068) + (RT_{LC} \times 0.034) + (RT_{P} \times 0.036) + (RT_{E} \times 0.036) + (RT_{S} \times 0.018)$$

Where;

RT_R = Rated Value of resources.

RT_{GT} = Rated Value of government take.

RT_{LC} = Rated Value of local content.

RT_{SB} = Rated Value of signature bonus.

RT_{NOB} = Rated Value of number of block.

RT_{BR} = Rated Value of bid round.

RT_P = Rated Value of political.

RT_E = Rated Value of economic.

RT_S = Rated Value of security.

Phase 4: Data Compilation

Under data compilation, the results generated will be evaluated. Each result produced from each component for each country will be discussed in this report. The amount of resources, government take, local content and other sub-components in each country are going to be compared in order to find the best exploration hotspots. A three dimensional graph of resources, accessibility and fiscal terms is going to be created to see the rank and position of each country evaluated under this study.

3.2 Gantt Chart and Key Milestones

FYP 1:

No.	Activities	Weeks													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	FYP 1 briefing and selection of topic														
2.	**Countries selection**														
3.	**Identification of parameters**														
4.	**Identification of sub-components**														
5.	**Study on the resources parameter**														
6.	**Study on the fiscal terms parameter**														
7.	**Study on the accessibility parameter**														
8.	**Study on the country risk parameter**														
9.	**Creating methodology for the final score**														
10.	**Final selection of parameters**														
11.	Proposal Defence														
12.	Project Continuation														

Finalized countries selection **Finalized parameters**

No.	Activities	Weeks													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	FYP 2 briefing														
2.	**Analysis on resource potential and upstream environment**														
3.	**Analysis of fiscal regimes**														
4.	**Analysis on number of blocks and bid rounds**														
5.	**Analysis on country risk**														
6.	**Rating of the countries**														
7.	**Finalize the total score and ranking of the countries**														
8.	Poster presentation														
9.	Project continuation and report preparation														

FYP

Finalized analysis of parameters

Finalized data compilation and ranking of the countries

CHAPTER 4

RESULTS AND DISCSUSSION

After the analysis on countries identified as hotspots, eight countries have been selected for this project. The countries are Mexico, Angola, Gabon, Kenya, Cote d'Ivoire, Mozambique, Tanzania and Myanmar. These countries have been selected due to the impressive wildcats' success rate in the past 3 years as has been shown in Figure 14 below. But the case is different for Myanmar. Due to the international economic sanction that has been put on them until 2011, they are not able to import advance facilities and technologies. The E&P activities in Myanmar has been dominated by their state owned company, MOGE. But now, Myanmar is able to attract investors to come into their country and develop their vast potential resources which is mainly gas. The situation is almost the same as in Mexico except Mexico is ready to open their oil and gas investment after 75 years of the state owned company, PEMEX domination. The main reason is to get the expertise from major oil and gas players in developing their complex oil and gas reservoir in order to counter the decline from mature fields in the country itself.

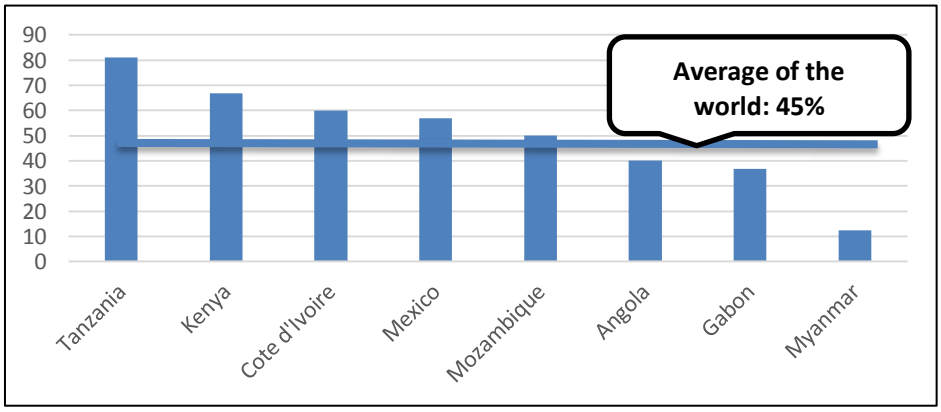

Figure 25: Wildcats success rate in selected countries

There are six countries form the African region selected for this study. The main reason is in between 2009 and 2013, 30% of the world discoveries have been dominated by the Sub-Saharan African region. In 2012 alone, Sub-Saharan Africa region represents more than 50% of the world discoveries, mostly contributed by the Kwanza pre-salt basin in Angola and large gas discoveries in Tanzania and also Mozambique.

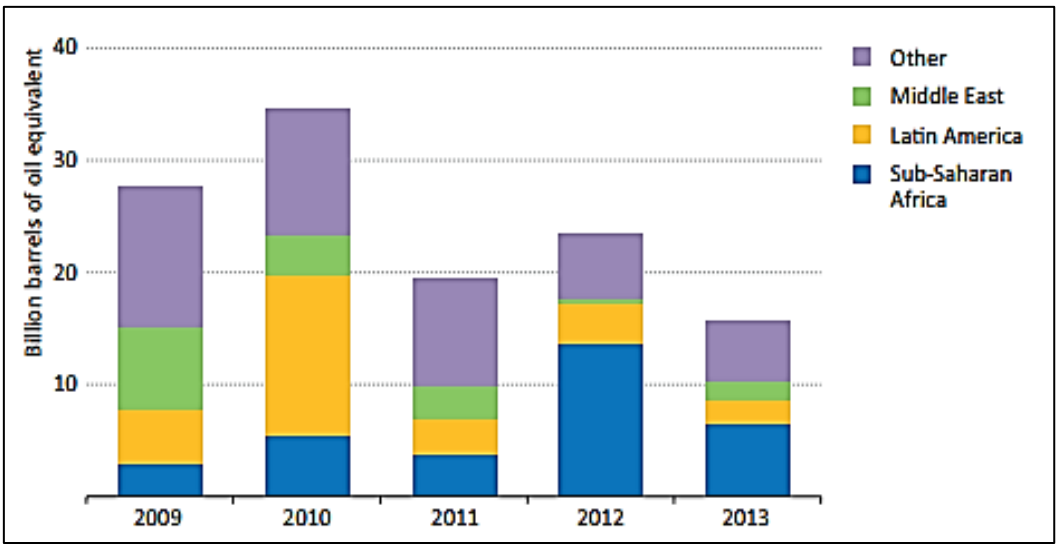

Figure 26: Oil and gas discoveries between 2009 and 2013

To analyse the selected countries, four parameters have been identified. The chosen parameters are amount of resources, fiscal terms, accessibility and country risk. Under amount of resources, yet to discover resources is going to be used in analysing it. There will be three sub-parameter under fiscal terms which are government take, local content and signature bonus. Number of farm in and open blocks will be the sub-parameter for the accessibility together with the bid rounds. For country risk, political, economic and security stability are going to be assessed as the sub-parameters. These sub-parameters have been rated accordingly. While the weightage of the components have been calculated using Pairwise Method.

4.1 Data Gathering and Analysis

4.1.1 Angola

I. Upstream Environment and Resource Potential.

Table 11: Summary of Angola Upstream Environment

Population and GDP	Yet to Find Reserve	Production	Players	Export
•Population: 21.4 million. •GDP: $124.2 billion. •GDP/capita: $5170. •GDP Growth: 6.7%.	•Oil: 2.6 Bboe. •Gas: 0.5 Bboe.	•Oil 2015: 1822 kboe/d •Gas 2015: 153 kboe/d •Oil 2030: 642 kboe/d •Gas 2030: 175 kboe/d	•A total of 47 companies are active. •BP, Shell, Eni, Sonangol, Chevron, Sinopec and etc.	•Oil: 1.5 mmbpd •Gas: 35 bcfd

- Upstream Environment

After Nigeria, Angola is the largest oil producer in the Sub-Saharan Africa Region. The first commercial oil discovery in Angola was made back in 1955 from Kwanza Basin. Most of the discoveries made in Angola are oil with an associated gas. In 2007, the number of discoveries in Angola was 15, the largest ever of the country. All of the discoveries were made in Lower Congo Basin with most of the well contains oil with associated gas (Figure 30). In the past decade, the exploration activities were focusing in deep water area. In 1990s, there are several deep-water fields found. The first deep-water field that has come online was Kuito Field developed by Chevron. As a result of the deep-water exploration, the oil production in Angola has increased by 15% in between 2002 and 2008. The significant contribution from deep-water area is expected to continue in the next few decades. Supply is always exceeds the demand in Angola. In 2014, the net export of oil in Angola was around 1.5 mmbpd. Asia is the largest export destination consists of 68% of Angola exports – led by China (49%). Oil is the macro-economy for Angola. Any changes in oil prices will hugely affect their economy. Although oil and gas are important to their country, biomass and

waste are the most consumed energy in Angola. It consists about 49% of the total primary energy consumed in Angola. This is due to the fact that only 30% of Angola population have access to electricity, forcing the majority of the population to use biomass and wastes as their sources of energy. In the past few years, the pre-salt exploration has emerged in Angola due to the pre-salt boom in Brazil. The first pre-salt discovery was made in 1983 by ExxonMobil and Cities Service. In 2011, Maersk Oil found oil in pre-salt region – Azul well, block 23. However, the first commercial discovery was only made by Cobalt in Cameia Field is expected to come on stream in 2015 – depending on oil prices.

- Yet to find reserves

According to the data provided by USGS, the amount of yet to find reserves of oil and gas are **2.6 Bboe** and **0.5 Bboe** respectively in Angola. Oil will be the focus for Angola since it is an oil prone region. In comparison with Malaysia, the oil reserves in Angola is about 80.7% more than oil reserves in Malaysia – Malaysia ye to find oil reserves is around 0.5 Bboe. For the past five years, Angola has successfully added around 3 Bboe of total reserves with 2013 is the peak year with 1 BBoe of reserves added.The trend of drilling activity has been fluctuating since 1980s. In between 2011 and 2013, the number of well completion has been increasing. But due to the drop in oil price, the number was decreased in 2014 as been shown in the figure 27 below.

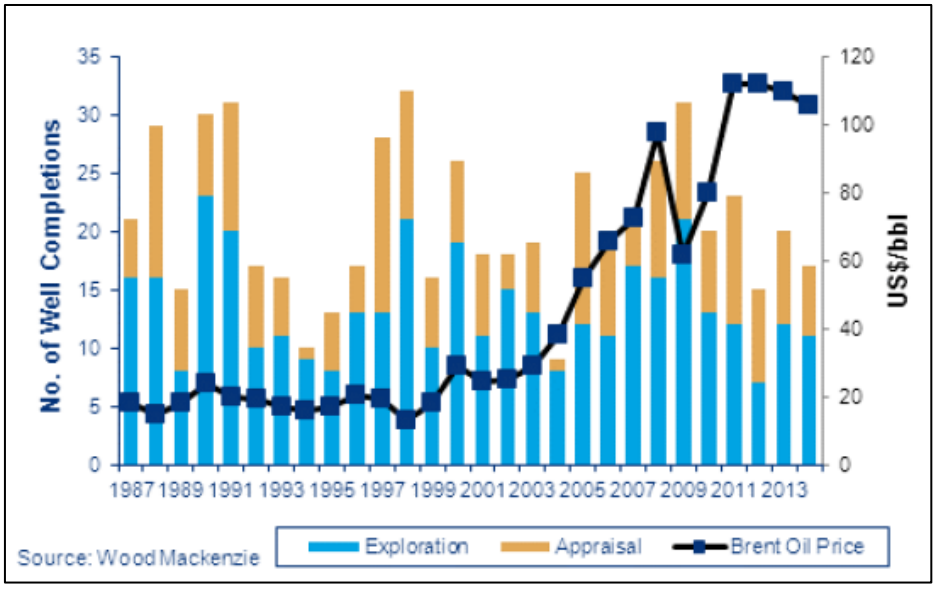

Figure 27: Number of well completions by year

Although Angola produce gas, most of the gas produced were either used for the re-injection process (EOR) or the gas is flared. In 2044, Wood Mackenzie predicts that the oil production to stop in Angola if no further exploration activities are conducted today. With the amount of reserves remaining together with the production rate in 2014, the oil in Angola is expected to only last for about 15 years – assuming there will be no exploration activities. According to Wood Mackenzie, Sonangol is company with largest remaining commercial and technical reserves as of January 2015 (Figure 28). It has around 3000 mmboe followed by BP and Chevron at 1900 mmboe and 1600 mmboe respectively. However, in terms of production, BP is leading the way with 330 kboe/d followed by Total at 300 kboe/d. Sonangol is only ranked at the 7th place with around 200 kboe/d (Figure 29). From the data, it is proved that Angola need the IOC to make the investment and help them with the technologies. This is because IOCs have more experience and better technologies for the exploration activities. Thus, it is crucial for Angola to continue with the exploration activities and open their oil and gas industry in order to fully develop their yet to find reserves since their economy is very much dependent on the oil export.

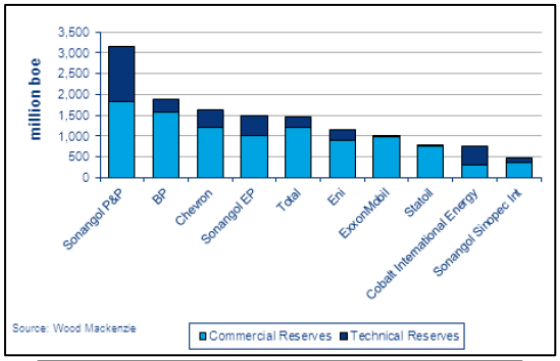

Figure 28: Commercial and Technical reserves by company.

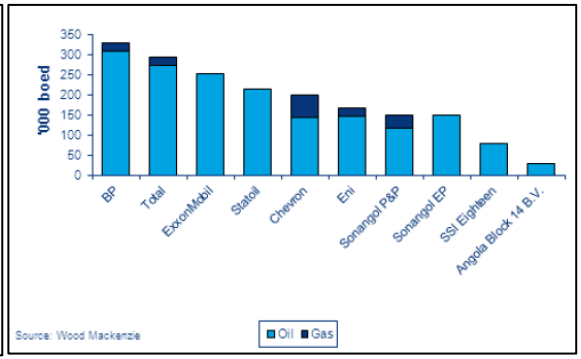

Figure 29: Production by company.

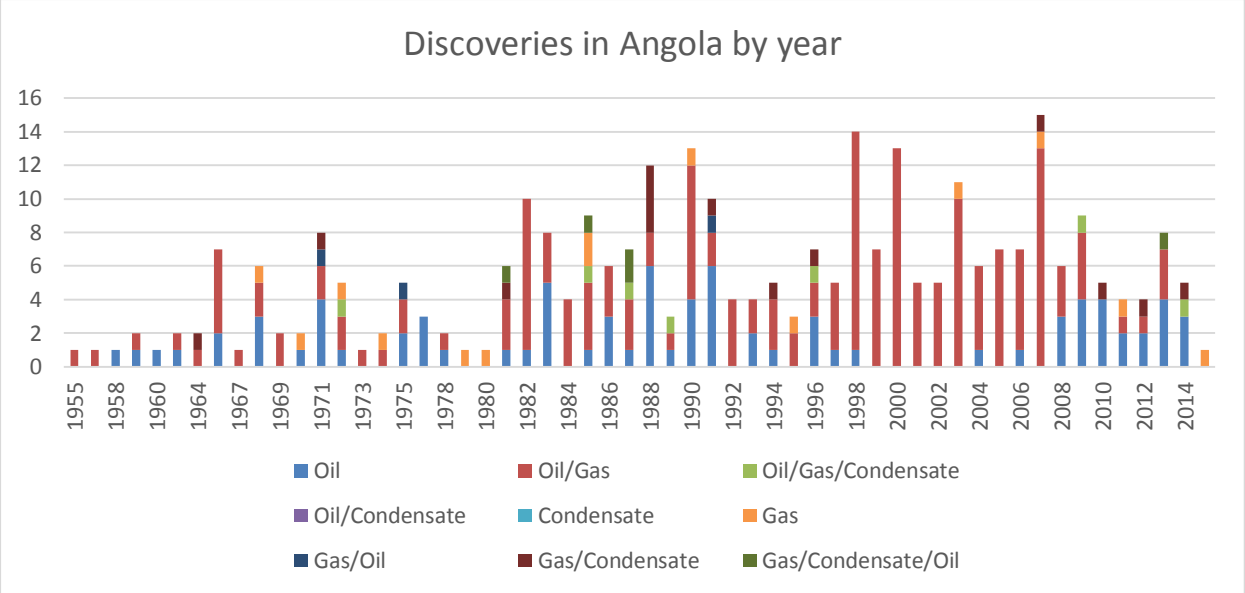

Figure 30: Discoveries by year in Angola

- Probability of discovery in Kwanza Basin:

Table 12: Kwanza Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	Mostly dominated by marine depositional environment with shallow marine as its sub-depositional environment.	1.0
	Effective pore volume	P50 value for porosity and permeability are 13.5% and 75md respectively at the depth of 2.5 km.	0.9
Probability of trap	Effective seal mechanism	Combined seal with conformable top surface and unconformable bottom side. The structural style is more to anticline with shale, anhydrite and carbonate as the seal lithologies.	0.9
Probability of charge	Quality and maturity of source rock	Average TOC content of 3.84%.	0.8
		Mostly type I/II kerogen.	1.0
		Average R_o content of 1.3%	0.9
		Average T_{max} value of 470 ℃	1.0
	Migration type and Timing	Trap : 113.7 MMyear Pet. Migration: 62 MMyear	0.9
		Largely lateral migration	0.9
Probability of retention	Erosion with westward tilting		0.8
	Probability of discovery		**0.378**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion rate
32%	1.72	82%	0.606

Local Content	70%

Table 13: Economic Analysis in Angola

Field Reserve Sizes	Reserve	Oil Price	NPV Government	Government Take	NPV Contractor	IRR	PIR
Very Small	10	40	167.338	0.725	141.603	0.28875	1.521253
		60	206.824	0.721	229.297	0.332772	1.880221
		80	245.381	0.715	317.921	0.368455	2.230736
		100	283.937	0.712	406.545	0.400738	2.58125
		120	322.494	0.710	495.169	0.43028	2.931764
Small	25	40	316.314	0.705	252.632	0.159022	0.510368
		60	506.913	0.735	383.980	0.22869	0.775718
		80	699.305	0.753	513.535	0.284135	1.037445
		100	891.697	0.769	643.090	0.331973	1.299171
		120	1084.089	0.775	772.645	0.374262	1.560898
Medium	50	40	772.562	0.704	459.929	0.17857	0.534801
		60	1226.609	0.703	660.446	0.239428	0.767961
		80	1682.993	0.702	858.626	0.290489	0.998402
		100	2139.376	0.702	1056.805	0.335847	1.228844
		120	2595.760	0.702	1254.985	0.376751	1.459286
Large	100	40	1737.838	0.762	1033.955	0.198826	0.70337
		60	2718.061	0.771	1464.920	0.260934	0.996544
		80	3699.411	0.811	1894.758	0.313938	1.288951
		100	4685.232	0.819	2320.127	0.35803	1.578318
		120	5671.052	0.825	2745.495	0.397364	1.867684
Very Large	250	40	4431.480	0.773	2583.328	0.22981	1.672057
		60	6881.782	0.802	3660.632	0.300579	2.369341
		80	9343.284	0.815	4726.735	0.357884	3.059376
		100	11807.578	0.822	5790.047	0.407062	3.747603
		120	14271.872	0.827	6853.359	0.450802	4.435831

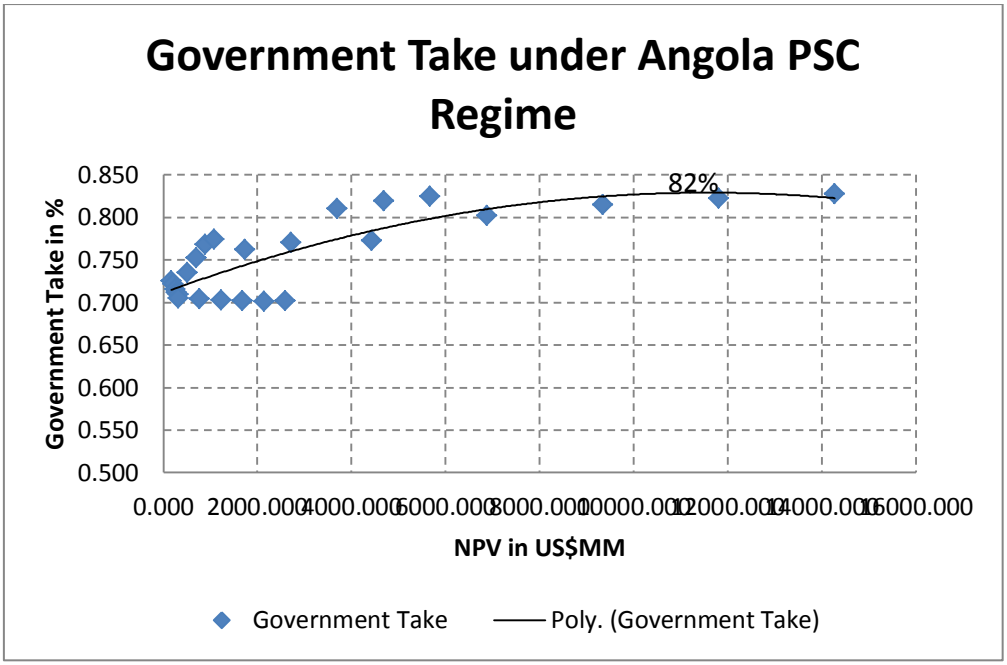

Figure 31: Government take in Angola

- Fiscal Terms

Angola prefer PSC model for the contact agreement for oil and gas industry. Looking at the 2008 model used for the deep-water fields, the government take is too high in Angola which is around 82% (Figure 31) at 50% cost recovery- the highest among the frontier countries. The average government take for the frontier region is around 68%. It is afraid that the high government take in Angola could hinder the development of deep-water fields in the country itself. Other than the government take, the income tax in Angola is also high. It is 50% of the investor's profit oil. Although the P/I ratio is quite good as compared to other frontier countries, the internal rate of return of 32% is far lower than the other – average of frontier region is 42%. Not to forget that there is also a negotiable signature bonus of 10 million USD payable by the investors. Other than that, there is also social contribution need to be paid by the investors at around 4 million USD. The domestic supply obligation has not been modelled under this fiscal regime but the government has the right to ask the NOC and IOC to supply at the market price. For now, the fiscal terms offered by Angola are not looking so good. In order to attract investors, they have to revise their fiscal terms so that it will be more attractive.

- Local Content

The local content in Angola in quite high which is around 70%. The high local content in Angola is done in order to help their NOC, Sonangol to have a better technical and financial capacity. Since Angola is a significant producing country, especially in Sub-Saharan African region, it is assumed here that most of the employees have sufficient ability and skills to work in oil and gas industry. But, Sonangol, the NOC still need the help of the IOC to fully develop their oil and gas resources especially in deep-water and pre-salt areas especially with the new technologies and advanced facilities that IOC can supply. The investors are required to teach the local workers on the knowledge regarding the exploration activities in the deep-water and pre-salt areas – technology transfer. They are also required to buy equipment and other facilities required from the Angolan companies at a lower taxes if the equipment needed are 10% higher than the normal price at the market. Other than that, investors are required to use the local banks in order to do any transaction activities in Angola. Thus, in the case of these two areas – deep-water and pre-salt, more involvement from the IOC's side are needed. Even though the local content in Angola is quite high, it is not as bad as it looks. It can still be rated in the average zone.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
41	7	Offshore Round – Unconfirmed (2015)

- Infrastructure

  Lack of infrastructures to develop gas fields has made the gas more difficult to be commercialized. However, it is vital for Angola to start developing gas infrastructures since Wood Mackenzie expects the gas production to increase by 22 kboe/d in 2030 from 2015 level and the oil production to drop quite significantly. As for oil, the facilities are already there in Angola. The crude oil that is produced either in mainland and deepwater will be stored and uses tanker loaded offshore to export. While crude oil from the shallow water is usually transported via pipelines in Angola. They also have a refinery plant, Luanda Refinery for domestic purposes. It has a processing capacity of 40 kboe/d. They are also planning another refinery, Lobito Refinery with a capacity of 200 kboe/d expected to start its operation in 2017 or 2018. As for gas infrastructure, an LNG plant was planned and approved back in 2007 with an initial capacity of 6.6 bcm/year. However, the plant has encountered many problems and expected to resume its operation the earliest by mid-2015. There is also a plan to construct a pipeline routes for the gas transportation in Angola. But the pipeline will only be used to transport gas to the LNG plant.

- Number of open and farm-in opportunities blocks

  All the farm-in opportunities blocks available for bidding are from Kwanza Basin. The blocks that are ready to be offered are block 05/06, 08, 09, 20 and two basins in block 23. All blocks apply PSC terms except for block 21. Block 21 uses risk service for the contract and all of the blocks are in deep-water terrain. Cobalt and Maersk are the operators for most of the blocks except for block 05/06. This operatorship of this blocks belong to VAALCO Angola. As for the open blocks, the number is quite high which is 41. Most of the basins offered are in Lower Congo, Kwanza and Namibe

basins. There are 19 basins offered are in onshore region and the other 21 basins are in offshore. All of the resources are conventional. Overall, the number of blocks offered are 48 in total. Most of the blocks are in open areas and most of them are in the surface exploration stage especially for farm-in opportunities blocks.

- Bid Round

  Angola already had a bid round for onshore round in the first quarter of 2014. The bid rounds have already finished in 2014 with 15 blocks have been offered. Those blocks are in Lower Congo and Kwanza Basins. However, Angola is planning to hold an offshore bid round expected to commence in 2015. There are 12 blocks expected to be offered with 7 of them are in Kwanza Basins and 5 of them from Lower Congo Basins. But the bid round is still unconfirmed at the moment. Wood Mackenzie expect the round to be delayed.

IV. Country Risk

Sub-components	Rating	Description
Political	2.2	➢ Politic in Angola has been dominated by the Popular Movement for the Liberation of Angola since they have been granted with independence in 1975. ➢ The election in 2012 was the first election that uses parliamentary presidentialism system in which the candidate that receives the most number of votes will become the president. ➢ The president of Angola, Jose Eduardo Dos Santos, who has been in the position since 1979 is said to be ready to handle the president position to a successor chosen by him. ➢ The power is in the presidential cabinets, make the Angola politics opaque to personal interest. ➢ Control over the judiciary system by the president increases the corruption risks in the country itself.
Economic	2.3	➢ Angola economy is concentrated in the hydrocarbon sector whereby 95% of its export are were coming from this sector. ➢ The development progress is hindered due to the high cost of trade. ➢ The investment environment in Angola is quite risky and weak. ➢ Supply chain constraint, very tight labor market and unpredictable utility prices might affect the operating cost in Angola. ➢ It will take some time for Angola to fully remove the risks associated with economic. ➢ Growing interests from investors, followed by increased in security risks will help Angola economic to move forward. ➢ Export base, secondary and tertiary industry will be the main drivers in pushing the economic growth in Angola.
Security	2.0	➢ Civil conflict in Angola has ended in 2002. To build new infrastructures in Angola, billions are needed and the money is coming from the hydrocarbon sector. ➢ Although the war has ended, the legacy is still there. The presence of land mines prove to be problematic. ➢ There is also a guerrilla conflict in Northern Cabinda enclave. However, the conflict has said to be ended and it is a low level conflict. ➢ The crime level in Angola is moderate. ➢ The rate of unemployment and poverty is high. ➢ Angola also receives threats from its neighbors. ➢ Political activism is started to increase due to high unemployment and poverty. ➢ Security forces has become the government's in stopping any activities by this group including oppositions.

4.1.2 Gabon

I. Upstream Environment and Amount of Resources.

Table 14: Summary of Gabon Upstream Environment

Population and GDP	Reserve	Production	Players	Export
•Population: 1.6 million •GDP: $19.34 billion •GDP/capita:$0 .12 million. •GDP growth: 5.9%	•Oil: 3.2 Bboe •Gas: 0.12 Bboe	•Oil 2015: 278 kboe/d •Gas 2015: 11 kboe/d •Oil 2030: 31 kboe/d •Gas 2030: kboe/d	•Total •Shell •Parenco •VAALCO •SInopec •Maurel & Prom	•Oil: 218.9 kboe/d

- Upstream Environment

Gabon has been listed as one of the five top producer in the Sub-Saharan Africa region. Similar to Angola, oil and gas industry has huge effect to their economy. It accounts for 56% of the government revenue. In fact, in 2011, 90% of the total export has been coming from the hydrocarbon sector. Gabon does not have NOC until 2011 when the government realize the need to have NOC in order to increase their equity stake in any contracts awarded to oil and gas companies. They were once a member of OPEC but in 1994, they have decided to quit the organization due to the high annual fees need to be paid by the members. The exploration activities have been focusing on shelf and shallow areas. But, the focus now is expected to be shifted into deep-water and pre-salt areas in order to counter the decline in production from mature fields and lack of new discoveries. In terms of facilities, Gabon has two land-based export terminals and four floating storage and offloading terminals (2 FPSO and 2 FSO). Other than their economy, hydrocarbon sector has been vital to their total electricity generation. In 2010, hydrocarbon consists of 55% of total electricity generation in Gabon. 60% of the population have access to electricity leaving the other 40%, mostly in rural areas to use biomass and wastes as their sources of electricity – EIA. Due to the similar geological structures as in Brazil pre-salts, the exploration in Gabon has attracted the interest of the investors to exploit their natural resources.

- Yet to Find Reserves

The data provided by USGS estimates that the amount of yet to find reserves for oil and gas in Gabon are **3.2 Bboe** and **0.12 Bboe** respectively. In comparison to Malaysia yet to find oil reserves, the reserves in Gabon is about 84% higher. For the past few years, the exploration activities in Gabon has slowed down. The number of well completion in Gabon has been decreasing. In 2014, there were only 7 well have been completed compared to 16 in 2010. Most of the wells drilled recently are exploration wells (Figure 31).

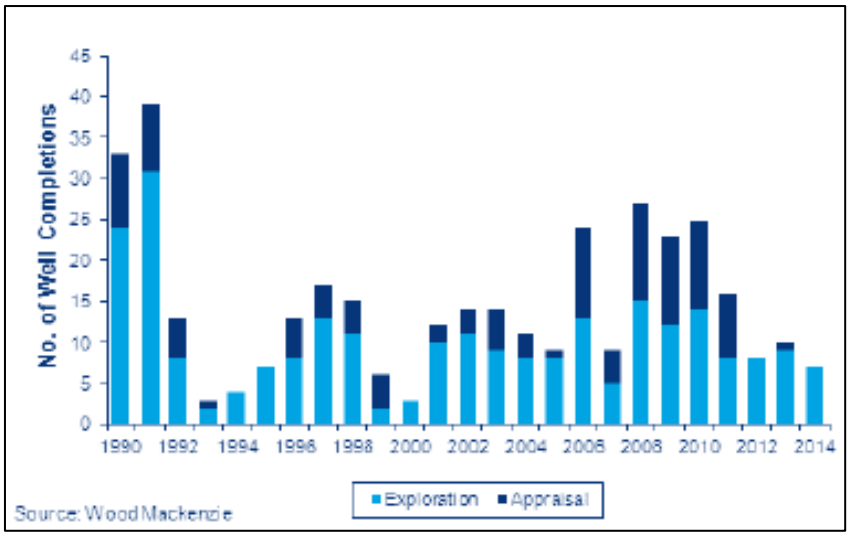

Figure 31: Well completion by year in Gabon

Gabon has gas production but similar to Angola, most of the gas produced in Angola were either used in re-injection process or it is flared. There was an effort made to build up a pipeline in order to transport the produced gas. But, it is only for the use of the onshore plant not for the commercialization of the gas. According to EIA, about 90% of the gas are used for re-injection and flaring. Only 10% of them, which is around 7 Bcf (2012 data) are marketed. The first oil discovery in Gabon was made in 1951 in Interior Sub Basin. Since then, the exploration activities were continued and in 1982, Gabon have found 10 new discoveries with mostly oil. After 1982, the discoveries in Gabon have been ups and downs. Due to mature fields and decline in production, Gabon have decided to shift their attention to the deep-water and pre-salt exploration. Most of the discoveries made in Gabon were concentrated in three basins which are South Gabon Basin, North Gabon Basin and Lower Congo Basin. In 2015

up to date, there was only one discovery made in South Gabon Basin through Mabounda 1D well. Most of the discoveries also made in either shallow water or onshore with only three discoveries made in deep-water region in 2012, 2013 and 2014. One of these discoveries was in North Gabon Basin and the other two were in South Gabon Basin (Figure 32).

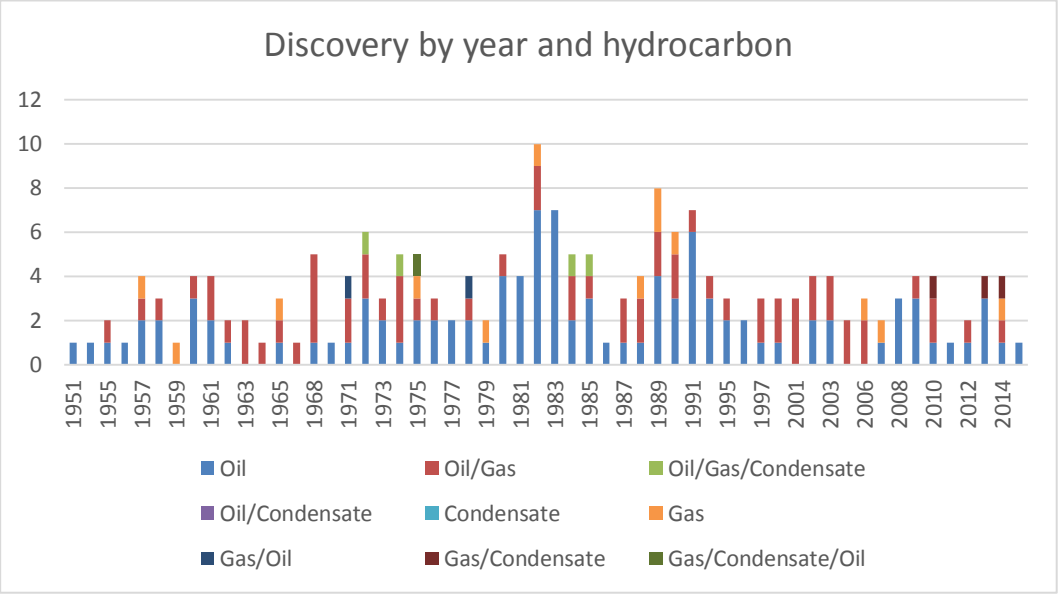

Figure 32: Discoveries by year in Gabon

On production, Gabon was first produced its first oil back in 1965. In 1996, Gabon experienced its peak production at around 350,000 kboe/d according to Wood Mackenzie. In 2014, the production of Gabon was at 269 kboe/d. Its remaining reserves was 0.89 billion barrels, the oil can only last for 9 years. As for the gas, Wood Mackenzie expected it to last for 13 years. Total Gabon is the company with the largest technical and commercial reserves at the moment at 310 mmboe followed by Parenco (Figure 33). But for production, Parenco is leading the way in Gabon with 70 kboe/d of hydrocarbon produced in 2014. Wood Mackenzie expects the production for both oil and gas in Gabon to decline sharply after 2015 especially for oil. In order to counter this decline, the exploration in deep-water and pre-salt areas have to be done as soon as possible. If not, Gabon will face problems since their economy is largely dependent on hydrocarbon sector.

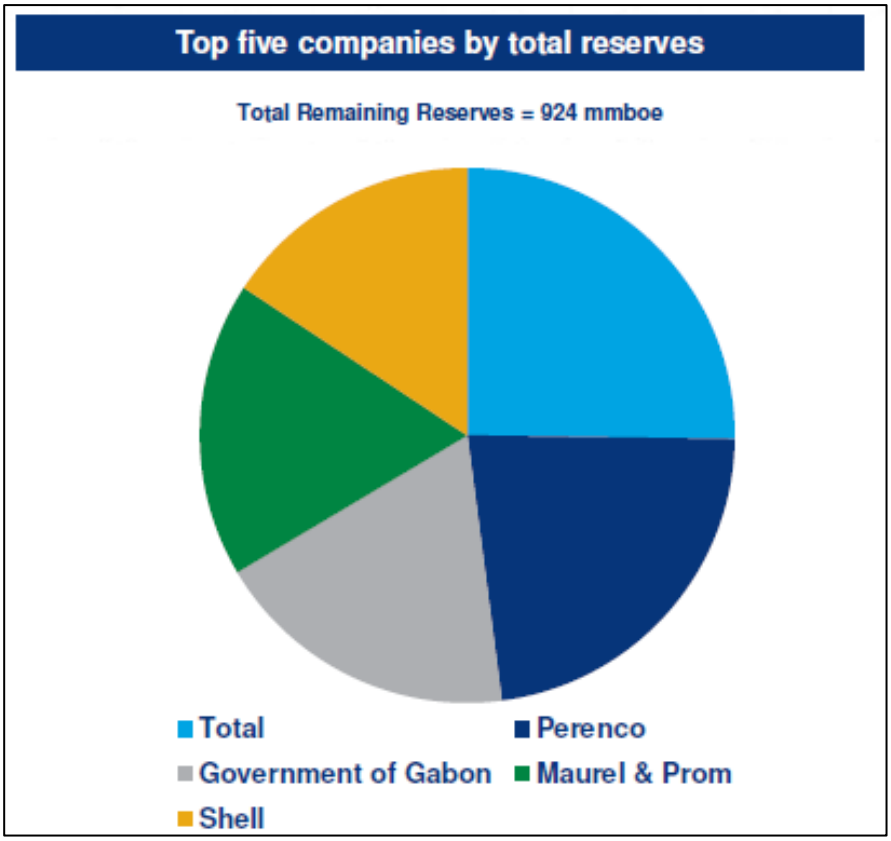

Figure 33: Reserves by company

- Probability of discovery in Lower Congo Basin

Table 14: Lower Congo Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	The main type of depositional environment is marine with some of the well penetrate terresterial type. The sub-depositional environment is dominated by the shallow marine and lacustrine.	1.0
	Effective pore volume	The P50 value of the depth, porosity and permeability are 2200km, 22% and 250md.	0.95
Probability of trap	Effective seal mechanism	Most of the play area have simple seal with unconformable as top surface and no bottom side. The structural type is either fault or anticline. The seal mechanism are mostly shale.	0.9
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 3.4%.	0.8
		Mostly contain type I/II or II/III kerogen.	0.9
		Average R_o of 0.898%.	0.9
		Average T_{max} of 447.67 ℃	0.95
	Migration type and Timing	The average trap age is 117.6 MMyear while the average age for petroleum migration is 42.6 MMyear.	1.0
		A significant lateral hydrocarbon migration into the reservoir rocks.	1.0
Probability of retention	There are deep erosions of the platform. No clear evidence on the information regarding trap connectivity.		0.8
	Probability of discovery		**0.421**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion
35%	2.04	85%	0.666

Local Content	90%

Table 15: Economic Analysis in Gabon

Field Reserve Sizes	Reserve	Oil Price	NPV Government	Government Take	NPV Contractor	IRR	PIR
Very Small	10	40	83.613	0.766	130.629	0.156948	0.760116
		60	142.043	0.747	215.641	0.234894	1.291303
		80	200.474	0.739	300.654	0.299388	1.82249
		100	258.363	0.734	386.194	0.352089	2.348757
		120	315.960	0.731	472.019	0.396803	2.87236
Small	25	40	342.564	0.787	252.531	0.184666	0.510163
		60	557.995	0.808	400.208	0.260329	0.8085
		80	773.426	0.818	547.885	0.323751	1.106838
		100	990.043	0.824	694.344	0.375912	1.402716
		120	1207.302	0.828	840.144	0.420373	1.697261
Medium	50	40	722.585	0.743	561.136	0.217044	0.652483
		60	1160.647	0.734	861.322	0.298826	1.001537
		80	1599.504	0.729	1160.693	0.366521	1.349643
		100	2041.223	0.727	1457.125	0.421002	1.694331
		120	2482.943	0.725	1753.557	0.468902	2.03902
Large	100	40	1634.109	0.818	1273.651	0.238434	0.866429
		60	2582.065	0.836	1917.208	0.316898	1.304223
		80	3530.314	0.844	2560.464	0.381486	1.741812
		100	4478.563	0.849	3203.720	0.436928	2.179402
		120	5427.529	0.852	3846.241	0.485211	2.61649
Very Large	250	40	4187.215	0.822	3234.541	0.274444	2.093554
		60	6557.591	0.838	4842.516	0.360728	3.134315
		80	8927.966	0.846	6450.491	0.431566	4.175075
		100	11299.362	0.850	8057.419	0.491833	5.215158
		120	13679.896	0.853	9654.966	0.541146	6.249169

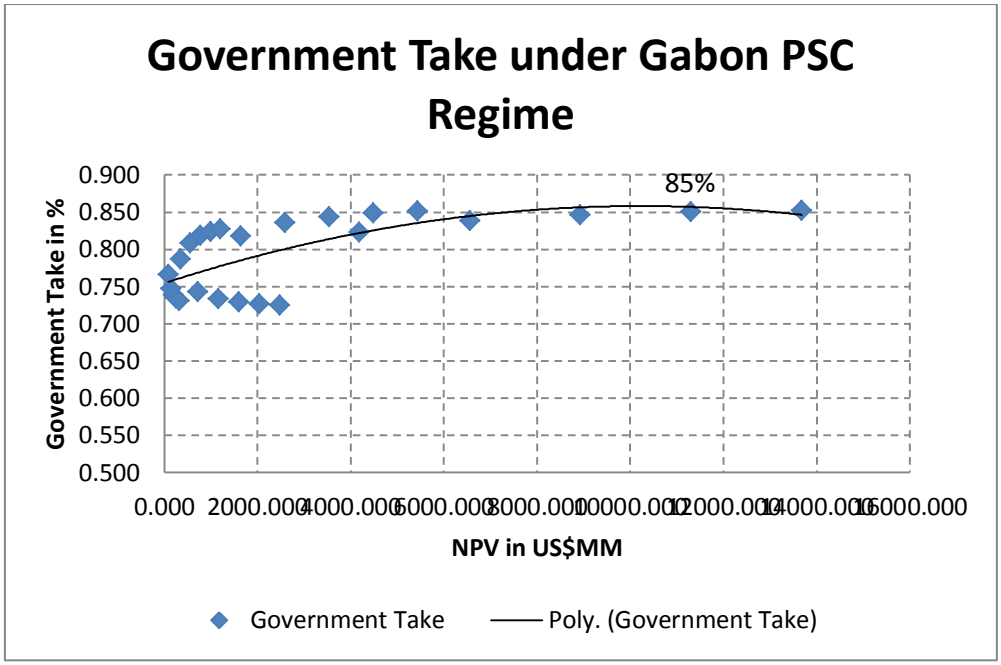

Figure 34: Government take in Gabon

- Fiscal Terms

Gabon prefers PSC model as their model for fiscal regime. Gabon has introduced a new petroleum code for the investors who are interested in doing oil and gas business in their country. In comparison to the previous fiscal regime, the new fiscal regime has a government participation through their newly formed NOC, National Oil Company of Gabon, increase in the production royalties and introduction of income tax. Gabon has a high government take of 85% (Figure 34). Although it is not as high as Angola, 85% is still be considered in the 'high' region. In comparison with the average government take for frontier region of 68%, it does not look good for Gabon. The P/I ratio for Gabon is quite good which is at 2.04. But the internal rate of return of 35% is way below the average for frontier region – average IRR for frontier region is 42%. Other than that, Gabon also impose an income taxes of 35%. In comparison with other country, it is among the lowest. Thus, in terms of income taxes, it is favorable to choose Gabon. But the state participation is quite high in Gabon. Government is expected to have a 20% share in any contract with National Oil Company of Gabon will have a maximum 15% participation. This percentage is the highest as compared to others. Furthermore, the ring fencing is applied around the contract area. Contractors are also required to pay some bonuses such as signature

bonus of USD 3 million and also production bonuses based on the production rate. There are also other payments need to be bear by the contractors. Some of them are training fee of USD 50,000, hydrocarbon support fund of USD 100,000, community project funding of USD 100,000 and many more. Production bonuses and profit sharing are determined based on incremental sliding scale of production which is one of the good things in the new fiscal regime. Overall, Gabon still need to do some modification in its fiscal regime in order to attract the investors for its deep-water and pre-salt exploration.

- Local Content

  The regulation in Gabon required the local involvement in each project to be 90% including in the management area. But the local employees will be selected based on their skills and qualification. The state will also provide a list of companies of which the investors can work with in Gabon. Gabon has been pushing for a stronger local content leading by the Gabon Oil Union since 2010. The contractor is also required to reduce the gas flaring up to 90% so that the associated gas can be used for electrical generation. Other than that, under the new petroleum code, the government has introduced Diversified Investment Allowance and Hydrocarbon Investment Allowance in which will be charged at 3% from the investor's revenue. For Gabon, the involvement of high local content might be okay for the shallow water exploration. But, the contractors might need more experts around them in order to efficiently do exploration in deep-water and pre-salt area.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
54	3	Closed

- Infrastructure

As has been reported by Wood Mackenzie, Gabon currently have two export terminals, four FPSO and one offloading terminal. The two export terminals are known as Cap Lopez and Gamba. Cap Lopez handles two type of blends known as Mandji and Rabi Light. Mandji blend is a mixture of crude from all fields except Rabi field. It is transported via pipelines to Cap Lopez. The crude is either used for local or transport outside Gabon. Cap Lopez has a storage capacity of 3.5 mmboe. As for Rabi Light, it is transported along two different routes. For Shell's equity crude, it is transported to Gamba terminal together with other crude in the terminal. The remaining crude is transported to Cap Lopez and they are not mixing with the Mandji Blend. The second terminal is known as Gamba. The Gamba terminal is handling the crude from Rabi Light and from the Echira, Niungo, Atora, Gamba, Moukouti and half of production from the Tsiengui and Obangué fields. Gamba terminal has a storage capacity of 1.5 mmboe. They also have pipeline as shown in the Figure 35 below.

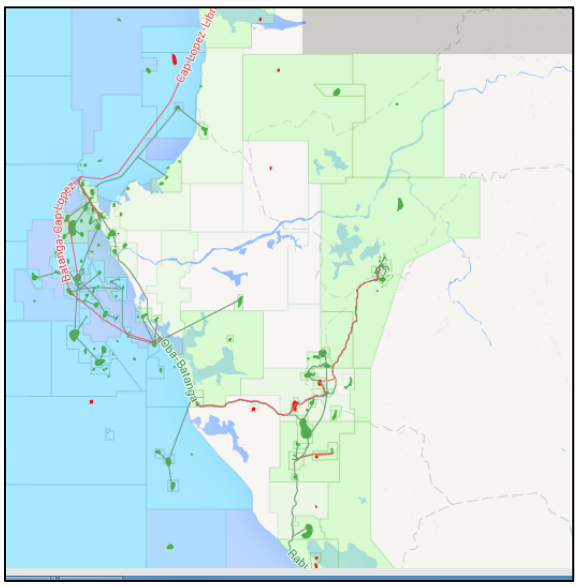

Figure 35: Pipelines routes in Gabon

- Farm-in and open blocks

  As of 19 May 2015, there are only 3 farm-in opportunity blocks available in Gabon. All of the blocks are located in the North Gabon Sub-Basin. The blocks offered are two Agali and one Nkembe blocks. But both contract in Agali blocks have been suspended. Only Nkembe block is in the surface exploration and drilling stages. The type of contract in Nkembe block is PSC with Pura Vida Energy as the operator. Nkembe block is located offshore and in a deep-water region. However, there are a lot of open blocks available in Gabon. At the moment, there are 54 blocks offered in open areas. The blocks are located in Gabon Doula, Congo Fan, Lower Congo, North Gabon Sub Basin and South Gabon Sub-Basin. Most of the blocks are located offshore. Only some of them are in onshore region such as block E8, EF7 and EF8. Overall, there are a lot of open areas in Gabon. But in order for the investors to start bidding, the bid round must commence first.

- Bid Rounds

  Gabon has finally pass its new upstream regulation in 2014. This new fiscal regime is tougher than the previous one. It remains to be seen whether the licensing round can help Gabon to increase their production or not. The last bid round in Gabon was conducted in 2013 with the agreements with the investors have been finalized last year. Originally, there are 43 blocks available but only 13 blocks have been awarded to the 11 companies for the next phases. From the 13 blocks, Gabon has announced in July 2014 that it is in negotiation with seven companies for 9 blocks. In August 2014, seven of the blocks were awarded with two of them are still in negotiation. However, there is a chance that Gabon will conduct a new bid round because there are 30 blocks available from the previous bid round although it is unclear whether those blocks will be offered or not.

IV. Country Risk

Sub-components	Rating	Description
Political	2.2	• The current President of Gabon has been accused of interfering the judiciary system of the system. • The serious bribery problem in Gabon is unlikely to be solve during his tenure. • In order to reduce the dependency of Gabon on oil and gas industry, they have decided to diversify the economy as the part of 'Emerging Gabon' plan. • The protests from opposition together with the police violence is expected to continue especially with the 2015 Senate and 2016 President Elections are around the corner. • Public strike is likely to continue due to the increase in living cost and to force the government to meet their demand.
Economic	2.2	• Oil sector is very important to Gabon since it contributes to 81% of the exports, 65% of government revenues and 43% of their GDP. • The decline of oil production in Gabon will give a bad effect towards their economy in short to medium term. • The slow progress of the structural reform will make thing from bad to worse for Gabon since it will increase the downside risk to their business environment. • Under the supervision of IMF, Gabon will try to improve the judiciary system and speed up the reforms. • Gabon has successfully sold the Gabon Telecom as one of the hurdles in national privatization initiative. • The structural reform is the key to Gabon's economy. If they fail to accelerate the reform, it will be difficult for the non-oil sector to make up for the decline made by the oil sector.
Security	1.8	• Gabon's peace has been spoilt by the political divides in the country itself. • The issue became worse when Andre Mba Obame return in August 2012. • Number of demonstrations keep increasing in order to force the government to consider the national conference. • Industrial unrest is another problem faced by government of Gabon especially in oil sector. • Increase in the number of crimes and police corruption should expected by the investors when they decide to do the investment in Gabon.

4.1.3 Cote d'Ivoire

I. Upstream Environment and Amount of Resources.

Table 15: Summary of Cote d'Ivoire Upstream Environment

Population and GDP	Reserve	Production (2015)	Players	Export
•Population: 20.32 million •GDP: $31.06 billion •GDP/capita: $1529 •GDP growth: 8.7%	•Oil: 0.12 Bboe •Gas: 0.17 Bboe	•Oil: 32 kboe/d •Gas: 0.16 bcf/d	•Petroci •Anadarko •Total •LUKOIL •African Petroleum Corp Ltd	•Export in terms of refined poducts and electricity - mostly to Benin, Togo, Mali, Burkina Faso and Ghana, Namibia.

- Upstream Environment

Cote d'Ivoire is one of the countries in African region that has been recording a high GDP growth in recent years. There are three major sectors that contribute to the GDP which are service sector, agriculture sector and industry sector particularly energy. Service, agriculture and industry sector represent 49.4%, 28.8% and 21.8% of the total GDP of the country in 2012. According to the report by KPMG, about 2/3 of the population in the country are relying on the agriculture sector for a job. Cote d'Ivoire is one of the oil and gas producer in the West Africa region but it is not to significant. Most of the fields in the country have been matured to produce a large amount of oil and gas. The oil and gas exploration activities in Cote d'Ivoire has started as early as in 1980. In 1982, they have experienced a peak production. In the early stages, the exploration in the country has been focusing on the shallow water region. However, due to the discoveries in Ghana's Cretaceous turbidite play in deep-water region, oil and gas explorers believed that Cote d'Ivoire might have the same prospect as in Ghana. There are a lot of IOCs and small independents companies in the country looking to develop the deep-water prospects. But for now, there are only three companies with the production which are Petroci, Foxtrot International and Canadian Natural Resources.

- Yet to find reserves

As a small and mature producer in oil and gas sector, the amount of yet to find oil and gas reserves as being stated by USGS are **0.12 Bboe** and **0.17 Bboe** respectively.The amount of oil reserve, when compared to Malaysia, can be considered as good considering the deep-water play in the country is not fully develop yet. As in 2015, there are only 38 fields and 257 wells that have been drilled in the country. They have successfully added 439.4 MMboe reserves to their country since 2011 (Figure 36). From the two figures (36 ad 37) below, it is clearly shown with the increase number of well completions, the number of discoveries is also increase.

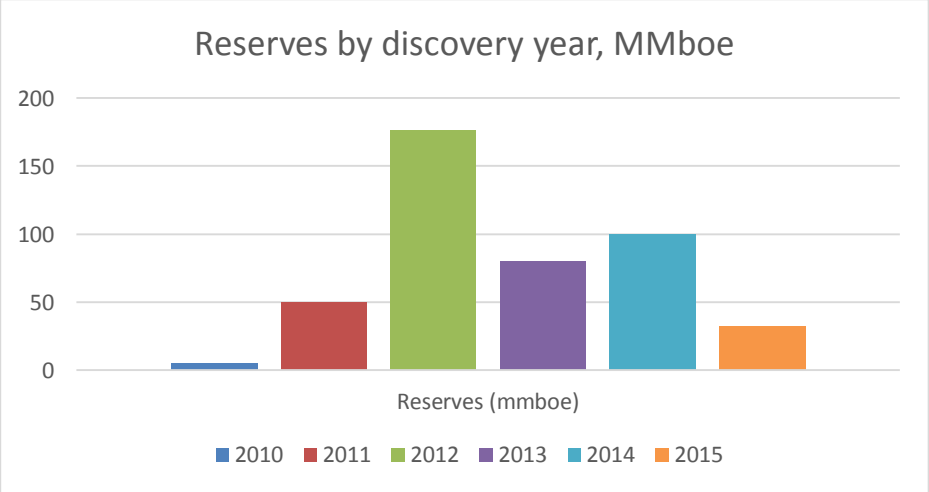

Figure 36: Reserves added by year in Cote d'Ivoire

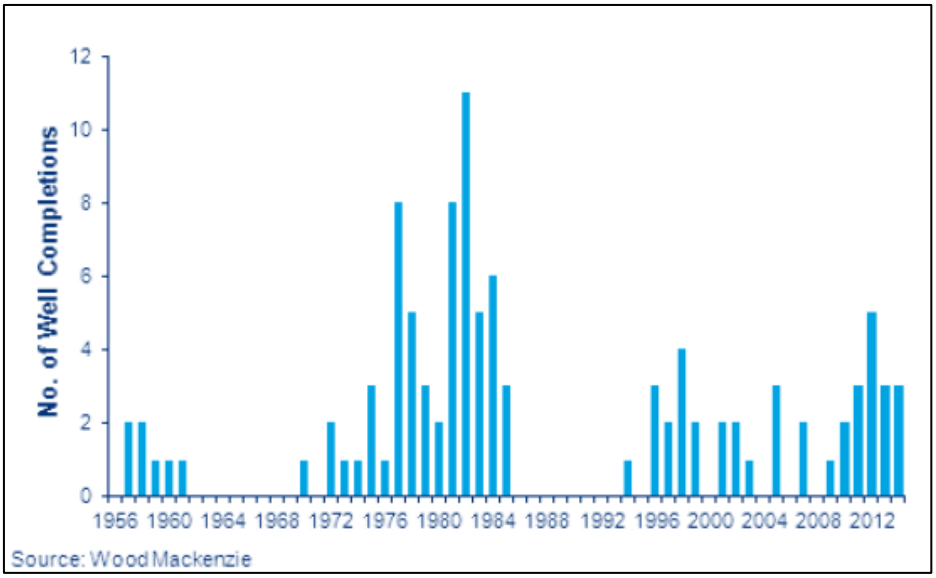

Figure 37: Number of well completions in Cote d'Ivoire

The first discovery in Cote d'Ivoire was made in 1972 through the Ivco 02 well that struck oil with the reported proven and probable reserves of 0.666 mmbbl (Figure 38). The operator of the well was ExxonMobil and the well has been plugged and abandoned. The discoveries in Cote d'Ivoire have been dominated by oil and oil with associated gas. In 1982, they have recorded five discoveries, the largest number of discoveries made in the history if Cote d'Ivoire with one gas discovery, two gas/condensate and two gas/condensate/oil. Since then, the average number of discoveries in Cote d'Ivoire is only two per year. It is vital for them to fully develop their deep-water region in order to increase the amount of reserves in their country. Liquid production in the country has dropped in 2014. However, it has recovered again in 2015 and Wood Mackenzie expect the production to increase until 2017 before it goes down again. The case is a little bit different for gas where they expect the gas production to be stable until 2022 before it starts to decline. The oil and gas remaining reserves in Cote d'Ivoire are expected to last for 12.7 and 12.2 years respectively. Overall, the production history and forecast is a good indication that the reserves can be developed. However, the continuous drilling on deep-water play is also vital in order to make sure that the reserves can be discovered in the first place.

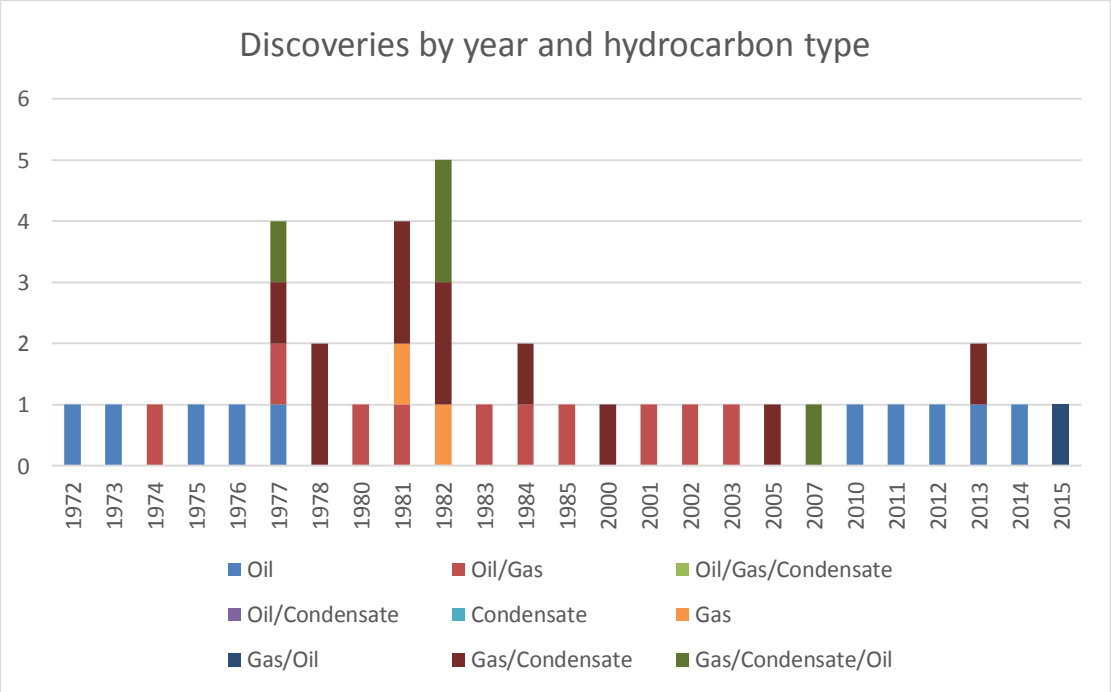

Figure 38: Discoveries by year in Cote d'Ivoire

- Probability of discovery of Cote d'Ivoire Basin.

Table 16: Cote d'Ivoire Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	Most of the geologies are with Marine depositional environment with sub-depositional environment of shallow and deep marine. There are also terrestrial with lacustrine/fluvial.	1.0
	Effective pore volume	P50 value of porosity and permeability 19% and 65md respectively. The P50 value for depth is 8.5 km.	0.8
Probability of trap	Effective seal mechanism	A simple seal with unconformable as top surface and unknown bottom side. Contain mostly faults as the structural style. Most of the seal lithology are shale.	0.8
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 4%.	0.8
		Most of the reservoirs contain type II or III kerogen.	0.85
		Average R_o value of 0.875%.	0.85
		Average T_{max} of 446.4 ℃	0.9
	Migration type and Timing	The average trap age is 110 MMyear while the petroleum migration age have an average age of 79.1 MMyear.	1.0
		Lateral migration along the sandy and fault area. It causes the vertical migration to take place due to change in sedimentary sequence.	1.0
Probability of retention	Reactivation of the normal fault system that improve the size of hydrocarbon area.		0.85
	Probability of discovery		**0.283**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion
46%	3.29	60%	0.779

Local Content	Will be introduced

Table 17: Economic Analysis in Cote d'Ivoire

Field Reserve Sizes	Reserve	Oil Price	NPV Government	Government Take	NPV Contractor	IRR	PIR
Very Small	10	40	144.762	0.509	149.967	0.233985	1.316022
		60	240.956	0.505	244.544	0.333037	2.190511
		80	337.150	0.504	339.121	0.4127	3.065001
		100	432.820	0.503	434.222	0.477364	3.934724
		120	528.205	0.502	529.608	0.532096	4.801865
Small	25	40	391.454	0.580	401.078	0.253042	0.810258
		60	631.095	0.598	644.357	0.349344	1.301731
		80	870.736	0.606	887.636	0.42739	1.793203
		100	1111.557	0.610	1129.735	0.491023	2.282292
		120	1353.017	0.610	1371.195	0.54505	2.77009
Medium	50	40	821.846	0.502	864.758	0.290527	1.005533
		60	1309.131	0.501	1359.318	0.39394	1.580603
		80	1797.206	0.501	1853.088	0.476841	2.154754
		100	2288.129	0.501	2344.011	0.543351	2.725594
		120	2779.052	0.501	2834.934	0.601209	3.296435
Large	100	40	1847.702	0.563	1949.846	0.310906	1.326426
		60	2901.761	0.585	3012.571	0.407984	2.049368
		80	3956.110	0.596	4075.005	0.485569	2.772112
		100	5010.460	0.602	5137.438	0.551013	3.494856
		120	6065.523	0.606	6199.158	0.607498	4.217114
Very Large	250	40	4720.600	0.566	4973.983	0.355446	3.219406
		60	7356.199	0.587	7629.792	0.4606	4.938377
		80	9991.799	0.597	10285.601	0.544659	6.657347
		100	12628.413	0.603	12940.396	0.615182	8.375661
		120	15274.117	0.606	15586.100	0.673277	10.08809

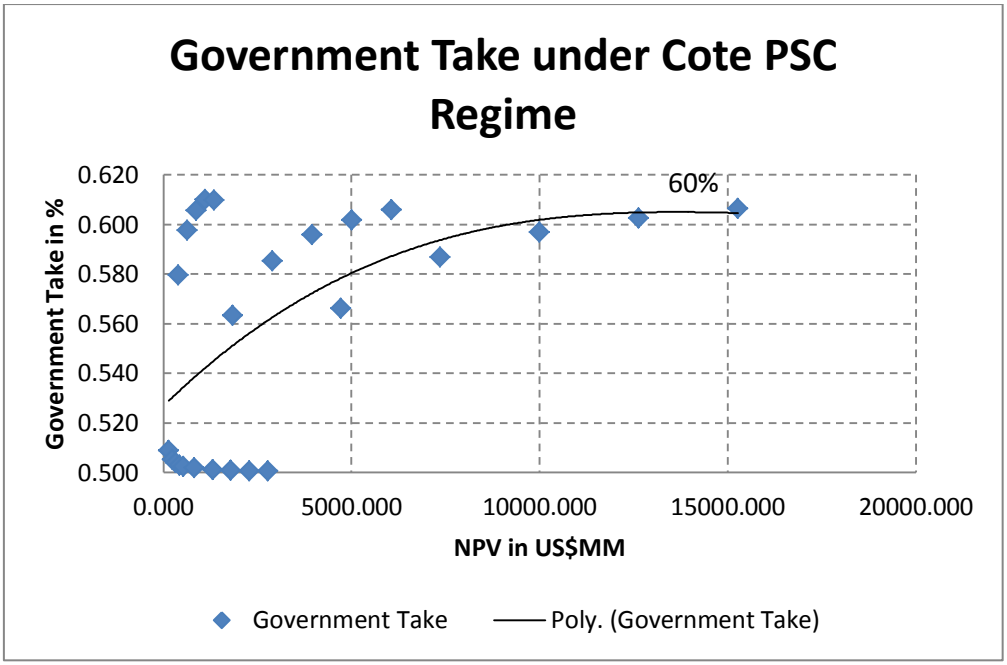

Figure 39: Cote d'Ivoire government take

- Fiscal Terms

Cote d'Ivoire's government take of 60% (Figure 39) is close to the average of the frontier region of 68%. In comparison with other frontier countries, this amount of government take can still be considered as low and good for the investor. The government take increases with the increase in value of R factor and production from the fields. As for the internal rate of return and P/I ratio, the value are 46% and 3.29 respectively. The 46% of internal rate of return is really high and it is one of the highest in the frontier region. Within 2 years, investors are expected to reach the breakeven. Other than that, P/I ratio in Cote d'Ivoire is also high and investors are expected to generate a higher profit as compared to other frontier countries. When the contract is signed, investors are expected to pay for signature bonus of USD 500,000 to USD 1 million in 30 days. There are also production bonuses payable to the government. Other than that, investors are also required to pay for the training fee of around USD 100,000 to USD 300,000. For domestic supply obligation, investors are expected to sell the crude to Petroci at 75% of the market price. The 25% remaining can be recovered from the future production. Overall, the fiscal terms in Cote d'Ivoire is looking really attractive for an upstream investment due to high IRR and P/I ratio helped by the average government take. A low signature bonus is vital since it will somehow affect the investor's final decision.

- Local Content

As for now, there is no such thing as local content requirements in Cote d'Ivoire. However, in recent years, the discussion on the needs for the local content to be implemented in Cote d'Ivoire has been rising. In a forum organized by World Bank in 2014 on the mining activities in Africa, one of the top issues that has been discussed was on the importance on the local content in Cote d'Ivoire. They have started a campaign to introduce local content in Cote d'Ivoire. In a new mining code approved in February 2015 and yet to be applied, the local content requirement will be introduced. The local content requirements in Cote d'Ivoire will include the priority to the Ivorian companies, providing training programs to the locals and have contributions in the mining administrations. Although the local content is set to be introduced, the exact percentage of local content requirement is yet to be determined. On the government side, the introduction of local content will help the local companies and indirectly improve their economy. But on the investors side, the introduction will be a burden since Cote d'Ivoire can be considered as new to the oil and gas industry and the employment of the local employees in a project will give some side effects especially if the percentage is high.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
31	4	Open

- Infrastructure

Although Cote d'Ivoire is a mature producing country, it has all the facilities needed for the oil and gas industry. As in 2015, there are two oil refinery plant known as Ciprel Refinery and SIR Refinery. Both of the refinery plants are used for domestic purposes. But, 20% of the refined products in SIR refinery plant exported to Burkina Faso, Nigeria and Mali. Other than that, there is also one gas plant known as Lion Gas Plant constructed in 1998. The production capacity of the plant is to 50,000 tonnes. The intake capacity of the Lion Gas Plant at the moment is around 35 mmcfd and it helps the domestic market by supplying 35% of the butane demand. The pipeline route and the plants location are shown in Figure 40.

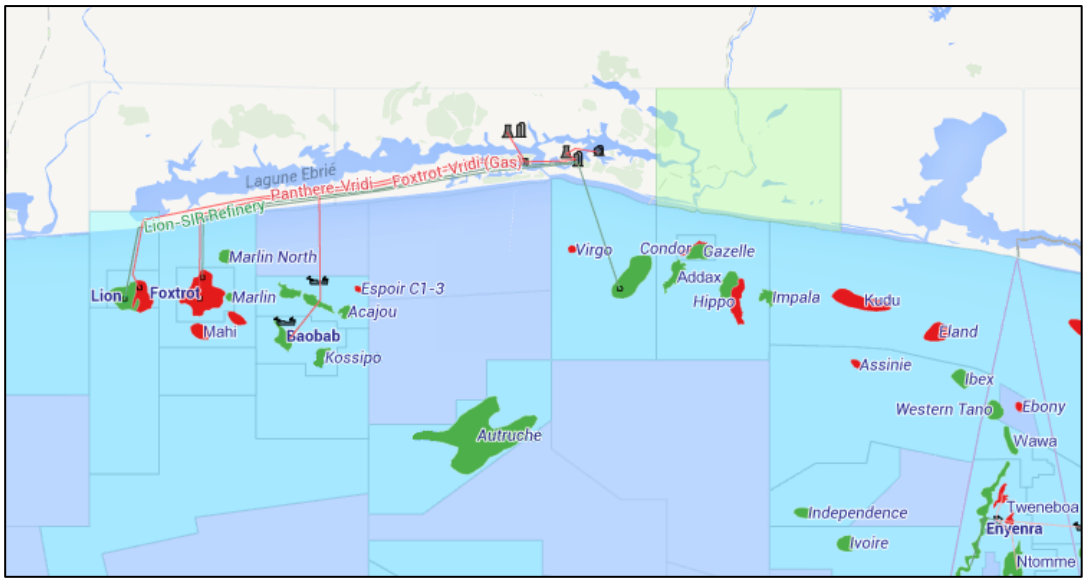

Figure 40: Plants and Pipelines facilities in Cote d'Ivoire

- Number of open and farm-in opportunities

  As in 2015, there are only 4 farm-in opportunities blocks in Cote d'Ivoire with all of them are still in the surface exploration and drilling stages. The blocks are CI-205, CI-206, CI-509 and CI-523. All of the blocks are located offshore and are in the deep-water region. The blocks are in Cote d'Ivoire basin. The operator in these blocks are Oranto Petroleum International and African Petroleum Cote d'Ivoire. The type of resources identified are conventional resources. As for the open areas, the number of open blocks are 41. All of the blocks are located in Cote d'Ivoire basin.25 of them are located offshore and in deep-water area and all of the resources are conventional resources. Most of the blocks are in the Atlantic Ocean main political province. The remaining blocks are in Gulf of Guinea, Lagunes, Sud-Badama and Sud-Comoe. In comparison with other frontier region, this amount of blocks is one of the highest after Angola and Gabon and it provide more opportunities for the investors. Other than that, it will be less competitive with bigger number of blocks. The available blocks are shown in Figure 41.

- Bid Rounds

  Bid Round is commencing now in Cote d'Ivoire for Deep and Ultra Deep Water Acreages. The bid round was announced in Houstan, Texas during the roadshow on October 14th 2014. There are 14 blocks set to be offered for bidding through direct negotiation. The blocks are Blocks CI-541, CI-542, and CI-543. Other than that, Blocks CI-600, CI-601, CI-602, CI-603, CI-604, and CI-605 are newly-defined, while Block CI-526 pre-dated the offering.

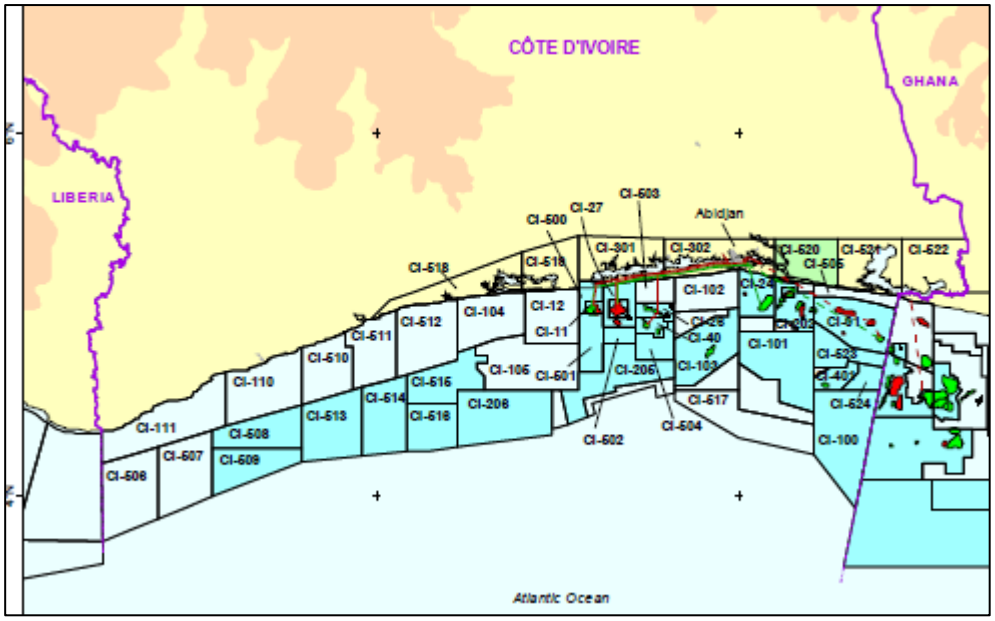

Figure 41: Licensed and open blocks in Cote d'Ivoire

IV. Country Risk

Sub-components	Rating	Description
Political	2.9	• The improved political framework together with the accession of President Alassane Quattara has allow Cote d'Ivoire to move forward politically. • Ivorian Popular Front President, Pascal Affi N'Guessan has agreed to participate in presidential poll in 2015 as a key to a better political environment but he must first hands off the challenge from Laurent Gbagbo. • The decision of the ICC to continue with Gbagbo trial might cause some political violence by Gbagbo's supporters. • The situation in the ruling party has been the same with three candidates from Democratic Party of Côte d'Ivoire (PDCI) want to challenge Ouattara in the next election.
Economic	2.8	• The economy is growing strongly at the moment but it is afraid that the upcoming presidential election might cause some unwanted/violence events that could disrupt the economic growth. • The economic growth has been supported by the government willingness to do reconstruction efforts and structural reforms that could vastly improve the business environment in the country. • The structural reform is the key to counter the poverty and for a better economic diversification.
Security	2.5	• There are still activities from the supporters of Gbagbo based in Liberia and Ghana but the government has done what is necessary to block the funds and improve border security. • The street protest due to Gbagbo trial is expected to be limited since the supports within the party have been divided – some of the party leaders prefer Pascal Affi N'Guessan's. • There are also banditry and extortion issues with most of them have been linked to Outtara. • Other than that, Cote d'Ivoire is also vulnerable to violent armed robberies. • The ethnic tension in the west of the country remains a tough challenge for the country. • Crime rate is falling but UN has identified Cote d'Ivoire as the center of weapon selling. • There is also an issue in the Ivorian sea where ship has been hijacked by the Nigerian pirates who has increase their activities especially in the Gulf of Guinea.

4.1.4 Kenya

I. Upstream Environment and Amount of Resources.

Table 18: Summary of Kenya Upstream Environment

Population and GDP	Reserve	Production (2014)	Players	Import
•Population: 44.35 million •GDP: $55.24 billion •GDP/capita: $1160 •GDP growth: 5.7%	•Oil: 1.3 Bboe •Gas: 0.5 Bboe	•Oil: 0 kboe/d •Gas: 0 kboe/d	•Eni •Tullow •CAMAC Energy •Africa Oil Corp •Total	•Oil: 20 kboe/d

- Upstream Environment

  Kenya does not have both oil and gas production in their country. In order to meet the domestic demand, they have to export the oil from UAE at 20 kboe/d according to Kenya National Bureau of Statistics. In terms of facilities, they do not have a pipeline for the export. But they do have a refinery plant owned by the government and India's Essar Energy. But, Essar Energy is ready to sell their share to the Government of Kenya. However, according to EIA, Tullow is ready to build an export pipeline between Uganda and Kenya. There will be another pipeline that connects Kenya and South Sudan's oil field as an alternative. Kenya is having serious problems with its facilities and transportation issues. Their export has reduced from 35 kboe/d to 12 kboe/d because of the failure of the refinery plant to sustain huge amount of oil. Oil has not been significant for Kenya. According to EIA, 68% of total electricity generation in Kenya are from renewable energy. The remaining 32% are from fossil fuel sources.

- Yet to Find Reserves

  USGS estimates the yet to find oil and gas reserves for Kenya to be **1.3 Bboe** and **0.5 Bboe** respectively. Kenya is not a country who produce oil and gas but they are identified as one of the hotspots due to the discoveries made in the past few years.

The first discovery in Kenya has been made by Tullow in 2012. The reserves are estimated to be 600 mmbbl in Block 10BB and Block 13T. Wood Mackenzie expects the first production to take place in 2020 with the peak production of 100 mmbbl/d. As of 1/1/2015, the liquid remaining reserves in Kenya is 0.63 Bboe. With the right facilities and equipments, the reserves can be well exploited. As in 2015, Kenya has successfully added 182.63 mmboe compared to the 2013 level (Figure 42). Other than that, the activity to exploit the hydrocarbon in Kenya is also increase with almost 20 of the wells have been completed last year, the largest in Kenya's history (Figure 43).

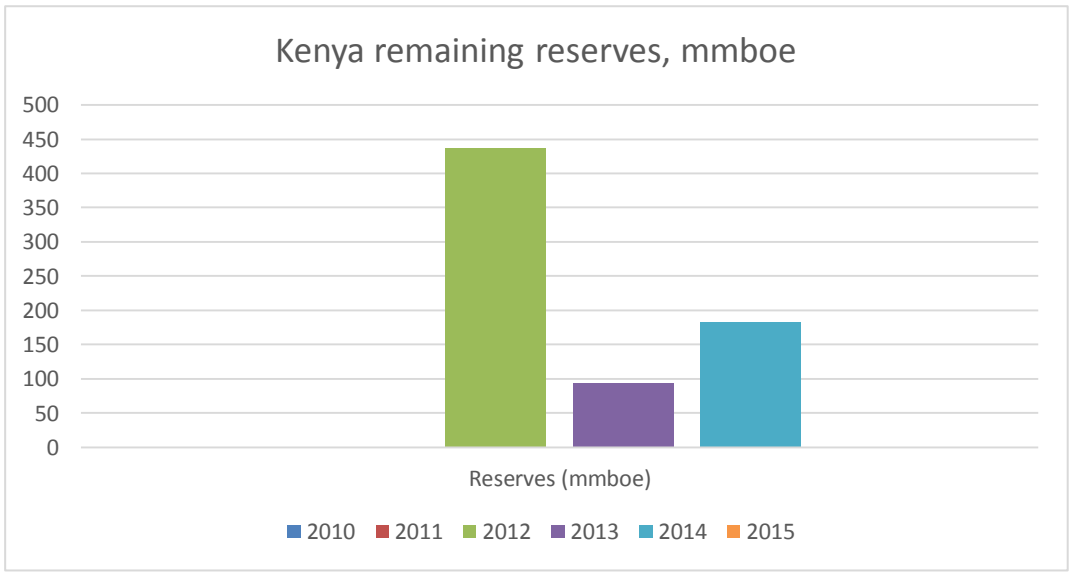

Figure 42: Kenya added reserves

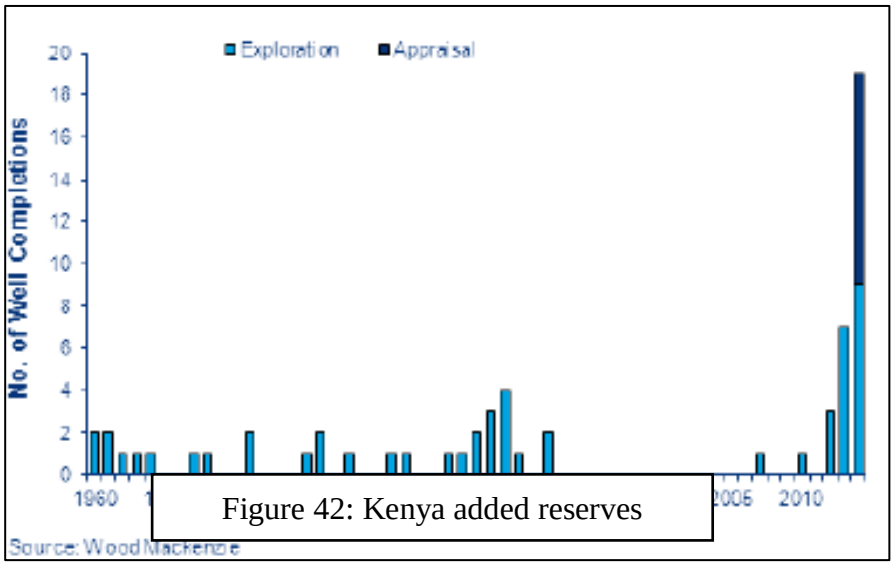

Figure 43: Number of well completion by year in Kenya

In terms of net acreages, Eni and Tullow lead the way with 35000 km2 for each company (Figure 46). Africa Oil Corp and Tullow are companies with largest commercial reserves of 300 mmbbl for each of them (Figure 45). In the past, the discoveries in Kenya are dominated by gas. As can be seen from Figure 44, in the first four discoveries made, three of them are reservoir with gases. But in the past 3 years, the trend was changing from gas to oil. Other than that, the number of discoveries in 2014 is the highest ever in Kenya. There were eight discoveries made with six of them are oil. The other two well struck gas and oil with associated gas. As for now, all the discoveries in Kenya have been made from three basins which are Lamu, Lokichar Trough and Yamicha Trough and most of them are onshore. From the many discoveries made, there were only two of them are in deep-water region. Most of them are in Shrubland terrain.

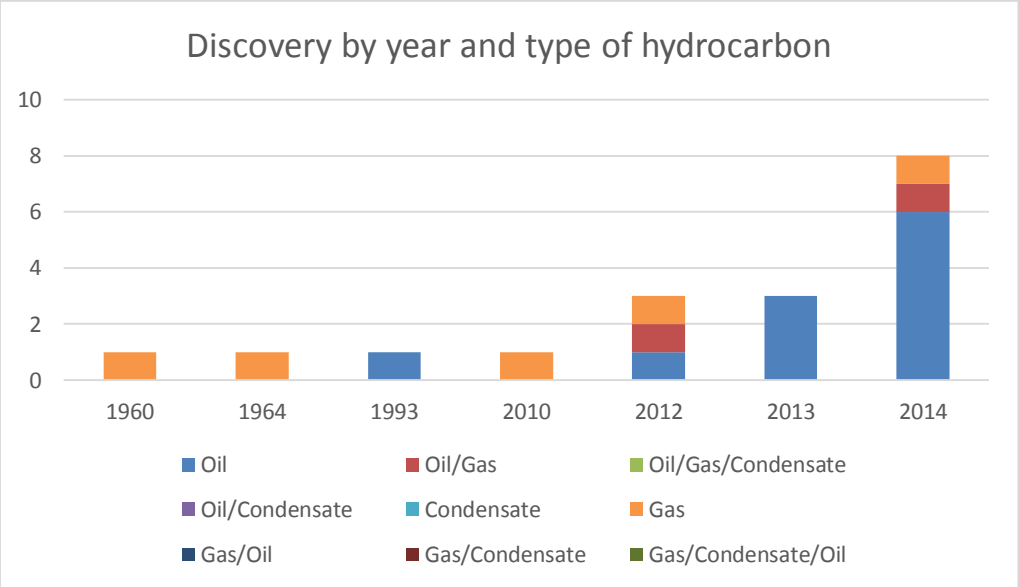

Figure 44: Discoveries by year in Kenya

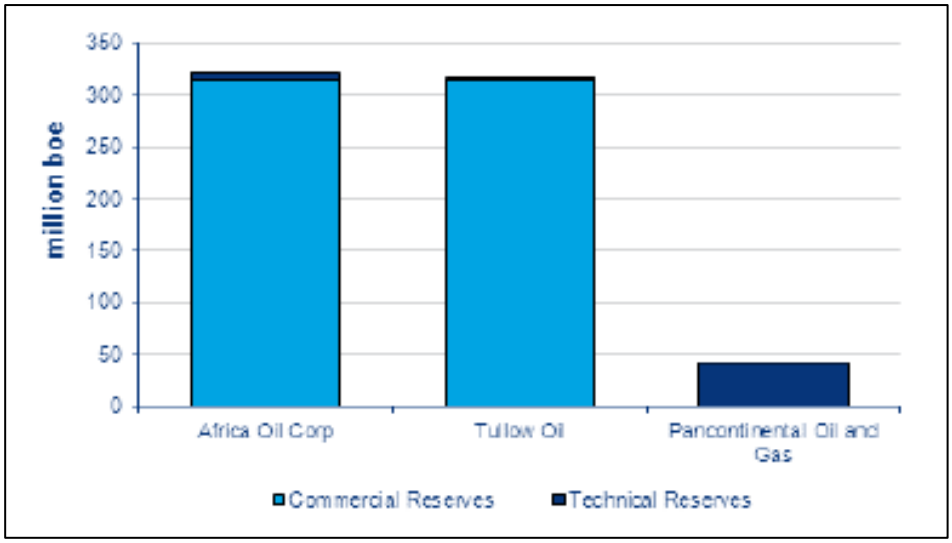

Figure 45: Reserves by companies

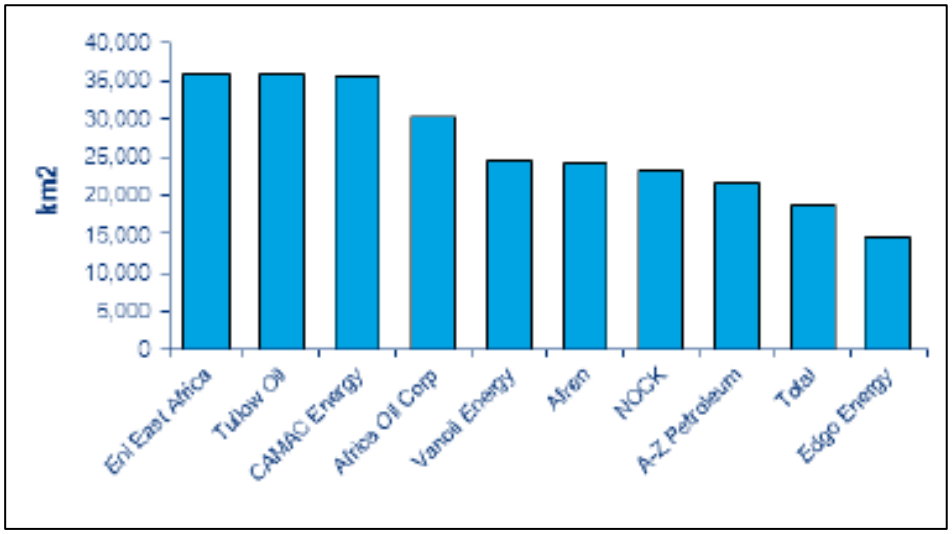

Figure 46: Acreages by companies

- Probability of discovery in Lokichar Basin

Table 19: Lokichar Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	The main type of depositional environment is terrestrial. The sub-depositional environment is dominated by the lacustrine and fluvial.	0.9
	Effective pore volume	The P50 value of the depth, porosity and permeability are 1300km, 16% and 250md.	0.95
Probability of trap	Effective seal mechanism	Most of the play area have simple seal with unconformable as top surface and no bottom side. The structural type is either fault block. The seal mechanism are mostly shale.	0.9
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 3.5%.	0.8
		Mostly contain type I kerogen.	1.0
		Average R_o of 0.85%.	0.9
		Average T_{max} of 445 ℃	1.0
	Migration type and Timing	The average trap age is 23.03 MMyear while the average age for petroleum migration is 23.03 MMyear.	0.85
		The hydrocarbon migrates laterally along the faults system and vertically to the shallow region.	0.9
Probability of retention	Possibility of rifting events across the basin. The status of the trap is unknown.		0.7
	Probability of discovery		**0.297**

II. Fiscal Terms and Local Content

Kenya 2008 Model PSC Terms

IRR	P/I Ratio	Government take	Tax distortion
46%	3.80	54%	0.759

Local Content	30%

Table 20: Economic Analysis in Kenya

Field Reserve Sizes	Reserve	Oil Price	NPV Government	Government Take	NPV Contractor	IRR	PIR
Very Small	10	40	159.177	0.445	121.595	0.210968	1.447061
		60	270.754	0.431	198.245	0.302939	2.461401
		80	382.331	0.425	274.895	0.37537	3.475741
		100	351.545	0.422	493.909	0.435718	4.49008
		120	605.193	0.420	428.488	0.486702	5.501753
Small	25	40	317.301	0.516	456.618	0.2533	0.92246
		60	511.481	0.534	738.919	0.348166	1.492766
		80	705.661	0.543	1021.220	0.423769	2.063071
		100	899.841	0.548	1303.521	0.487259	2.633376
		120	1094.681	0.551	1585.162	0.541105	3.202348
Medium	50	40	666.105	0.416	992.968	0.300354	1.154614
		60	1060.940	0.414	1566.888	0.404085	1.821963
		80	1455.775	0.413	2140.807	0.487044	2.489311
		100	1851.249	0.412	2714.087	0.556092	3.155916
		120	2248.438	0.412	3285.652	0.614018	3.820526
Large	100	40	1499.861	0.500	2247.582	0.325841	1.528968
		60	2349.680	0.523	3486.323	0.426957	2.371648
		80	3203.373	0.533	4721.189	0.505394	3.211693
		100	4057.066	0.540	5956.055	0.571023	4.051738
		120	4910.759	0.544	7190.921	0.627844	4.891783
Very Large	250	40	3824.970	0.502	5767.145	0.384363	3.73278
		60	5956.561	0.524	8856.411	0.495137	5.732305
		80	8090.572	0.534	11943.257	0.582487	7.730263
		100	10224.583	0.540	15030.103	0.655779	9.728222
		120	12358.594	0.544	18116.948	0.719417	11.72618

- Fiscal Terms

The type of contract in Kenya is PSC. Kenya has a high government take as other Africa countries in this report. The calculated government take for Kenya is 54%, the lowest in the frontier region. In comparison with the average government take, Kenya's government take is 19% higher. At the first sight, it may not be so good for the investors to do the investment. The income tax is paid by the government. But there is another 26% additional profit taxes need to be paid by the investors. The amount of taxes can still be considered as good when compared to the others. Although the government take in Kenya is high, the P/I ration and internal rate of return are high, which is good for the investors. The internal rate of return of 49% exceeds the average internal rate of return of frontier region. The P/I ratio of 2.04 is also among the highest as compared to other frontier countries. Other than that, there is also a signature bonus payable by the investors. Investor need to pay an amount of USD 310,000 at the time the contract is signed. Investors are expected to supply crude oil for the consumption of Kenya people. The crude oil for domestic supply is traded at market value, which means that the cash flow of the investors will not be affected. The higher government take in Angola has been overshadowed by the high internal rate of return and P/I ratio. Other than that, the signature bonus can be considered as acceptable. Overall, it is wrong to say fiscal regime is not so good in Kenya. But in order to attract more investors to do exploration activities, it is better for Kenya to start considering to lower down their government take.

- Local Content

There is no such thing as 'local content' in Kenya at this moment. But there is an effort made by Kenya through the Parliament to enact a new law that benefits the local industry and economy when investors do investment in their country. Other than that, under the Section 9(1) (g) of the Petroleum Act, the investor is required to train the locals and give the priorities to them when it comes to employments matter. Furthermore, the contractor is required to use equipment and facilities that are available locally so that it will contribute something to local businesses. However, for different PSC contact, there are different regulation for local content. The local

content for each PSC is negotiable. There are also concerns among the oil and gas contractors that the lack of experience and technologies will make things difficult for the contractors since they are required to put the priorities on local employees and equipment. They are also expected to help the local in contributing to build the infrastructures in Kenya. The lack of local content regulation in Kenya has somehow caused some unwanted events such as Tullow has to suspend its operation in Block 13T and 10B due to the opposition by the local community. The new law known as Energy Bill is expected to include the local content regulation as of its contents. In the new 2014 Energy Policy, Kenya has stressed the importance of local content regulation such as the contractors are required to train and give priorities to local employees. But in order for things to be clear, there are more need to be done by the government of Kenya for the investors to be more convinced in doing the investment in the country itself.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
16	10	• Licensing round – suspended • Relinquished Acreage Offer 2016 – Unconfirmed • New licensing round 2015 - Unconfirmed

- Infrastructure

In order to develop the oil and gas potential, Kenya has decided to build a new pipeline system. There are two routes that have been identified as the pipeline routes. The first route is heading to southern part to Mombassa and the second route is heading to the nothern part of Lamu. The pipeline that passes Lamu is the best option since it is in the region of Tullow's discoveries. However, the pipeline has to buried and heated due to the low quality of waxy of the crude. The pipeline is expected to be completed in 2020 in a USD2.9 billion project. Other than the pipeline facilities, Kenya has a refinery of 80,000 b/d capacity. It provides supply to Kenya, Uganda and nothern Tanzania. The refinery has failed to operate at its full capacity but the plan to upgrade the facility is already in place. The current pipeline route is shown below.

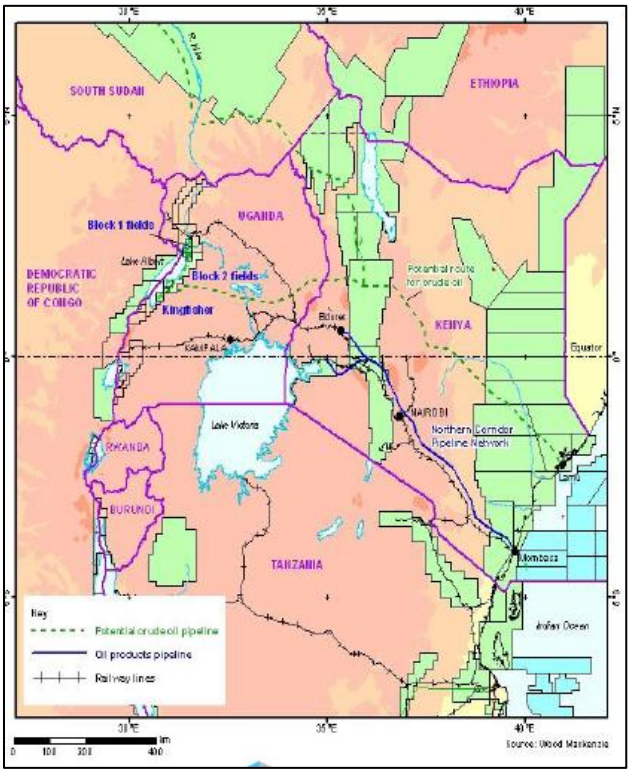

Figure 47: Oil pipeline routes

- Number of open and farm-in opportunities blocks

  As of 2015, there are around 16 number of open blocks available in Kenya. Most of the blocks are located in Lamu basin with others are in Mandera-Lugh Sub-basin, Yamicha Through, Anza basin, Lokichar Basin, Somali Deep Sea Basin and Turkana Graben basin. Half of the blocks are located offshore. Most of them are in deep-water region with only two blocks are in shelf and land area. The blocks are located in the political province of North-Eastern, Rift Valley and Indian Ocean. While for farm-in opportunities, there are around 10 blocks available in Kenya. From 10, 7 of them are in Lamu Basin, 1 of them in Lotikipi basin and the other 2 are in Mandera-Lugh basin. The type of contract used in these blocks are Production Sharing Contract (PSC). The status for the blocks are all of them are still in the surface exploration or drilling stages. Half of the blocks available for farm-in are in deep-water area while the others are in land area. Majority of the blocks are located offshore. Only four of the blocks are in onshore region.

- Bid Round

  Kenya is expected to pass its long-awaited new petroleum code in 2015. Along with the new petroleum code, IHS expects Kenya to hold a new licensing round in 2015 to fully develop the new commercial discoveries. Other than that, Kenya has suspended a licensing round back in 2013 in order to revise their natural gas and petroleum laws. There are 15 blocks expected to be offered by Kenya. Some of the blocks are available through the negotiation with the government of Kenya. Kenya has also voiced out their intention of offer the exploration acreages relinquished by Tullow and Anadarko. As for now, there 44 exploration blocks licensed to 23 companies. Kenya National Oil Company has also confirmed that there will be seven additional blocks ready to be offered when the bid round commences in 2016. The updated licensed blocks are shown in the Figure 48.

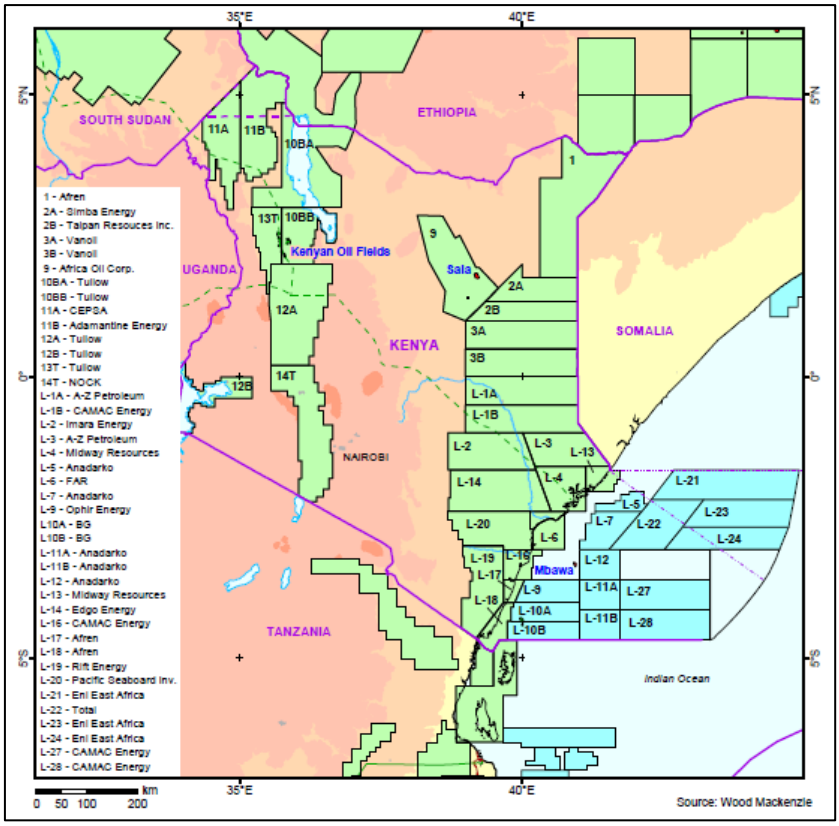

Figure 48: Licensed map of Kenya

IV. Country Risk

Sub-components	Rating	Description
Political	2.3	• The political stability in Kenya is quite good especially after the government has agreed to make institutional reform after violence in 2007 election. • The handover of power from Uhuru Kenyatta to William Ruto has been done peacefully but power struggles and turf wars are expected to take place. • The reluctance of the government to handle the power to 47 of the government administration has caused some other groups to compete for power. • The violence committed by Al-Shabaab group has pushed the government to applied political actions towards them, which has further increase the extremism and violence.
Economic	2.5	• Kenya has been one of the most important economies in East Africa except for the past two decades due to the political instability and weather condition. • Dynamic private sector has been vital to Kenya's economic but the political violence in 2007 has somehow give some bad effects towards their economy. • Their economy has expanded 8.4% before slowing down again few years after that. • The bad weather condition has caused the agriculture growth to be affected. • After 2011, the economy has somehow stabilized. The rebased national account statistics released in 2014 has shown 25% increase in GDP. • Although there are a lot of challenges waiting ahead, Kenya economy remains positive.
Security	2.9	• Ethnic, religion and communal cleavages threats from Al-Shabaab has been one of the struggles for Kenya to overcome. • Kenya is also vulnerable to terrorism attacks like what has happened in 1998, 2002 and 2013. • The number of attacks seems to be increased after Kenya agreed to send its troops across the border in 2011. • Failure of the government to contain the threats from Al-Shabaab, the communities were then accused of supporting the movement. • It is somehow increase the tensions in Kenya especially among the ethnics in the country.

4.1.5. Mexico

I. Upstream Environment and Amount of Resources.

Table 21: Summary of Mexico Upstream Environment

Population and GDP	Reserve	Production (2014)	Players	Export
•Population: 122.3 million •GDP: $1.261 trillion •GDP/capita: $9940 •GDP growth: 2.1%	•Oil: 3.97 Bboe •Gas: 4.64 Bboe	•Oil: 2586 kboe/d •Gas: 629 kboe/d	•Eni •PEMEX	•Oil: Export 1.19 million bbl/d. •Gas: net export of 0.8 tcf

- Upstream Environment

Mexico is one of the top oil producer in the world. However, for the past few years, the production has started to decline especially from mature fields such as Cantarell and Las Blancos. Oil has been vital to Mexico's economy accounting for 32% of government revenues and 13% of the total exports. Other than that, oil and gas have been consumed the most in Mexico with 53% and 36% of total primary energy mix respectively. In order to counter the decline in production, Mexico has decided to do the reform for their energy sector. In 2013, Mexico has passed a constitutional reform that allow greater number of foreign investments in their energy sector, ending 75 years of PEMEX monopoly. However, there are few problems affecting the implementation of the reform. Firstly, the secondary legislation which has been passed in August 2013. Second problem is the Round Zero in which PEMEX has been given the priorities to keep the acreages they want. The crude oil export in Mexico has reduced since 2010 due to the decline in country's crude oil production. But in 2013, Mexico still exporting around 1.19 million bbl/d with US as the country that importing the most. There are two potential identified in Mexico. The first one is the deep-water potential. Mexico has successfully found the first deep-water field with commercial amount of oil in Trion Field. Years after that, Mexico announced the second discovery in Supremus Field. These fields are located in Perdido Area. The second potential is the unconventional/shale potential. Burgos and Sabinas basins in

Mexico are said to be the extension of the Eagle Ford Basin of US. However, the complex structure of geology with faulting and folding has made the drilling activities through the shale formation in Mexico becomes more difficult and expensive.

- Yet to find reserves

According to the data releases by USGS, Mexico possesses about **3.97 Bboe** and **4.64 Bboe** of yet to find oil and gas respectively. For unconventional potential, PEMEX has estimates that there are 150 tcf of prospective gas reserves. As for oil, there are around 13 billion barrel of reserves as has been identified by the EIA. In comparison with Malaysia, which is a significant oil producer, the oil reserves in Mexico is higher by 3.47 BBoe and the second highest in frontier region after Brazil. First discovery made in Mexico was in 1904 that contains oil with associated gas. Since then, the number of discoveries made are increasing dominated also by oil with associated gas. In late 1980s to late 1990s, the number of discoveries made were reduced quite drastically. In 2000, it increases again but the trend has been changing from oil with associated gas to gas with condensate. The number of discoveries made have been declined again since then and Mexico is hoping with the new energy reform, more discoveries could be made in the future (Figure 51).

Figure 49: Mexico remaining reserves by year

According to Wood Mackenzie data, Mexico have added around 280 mmboe to their reserves since 2010 a9figure 49). The exploration activity in recent years has increased especially in the deep water region and it followed by few commercial discoveries – Gulf of Mexico. The production in Mexico has been declining in recent years (Figure 50). Mexico's energy reform is expected to arrest the decline in oil and gas production in the country itself. The forecast done by Wood Mackenzie, they expect the oil and gas production will keep decreasing until 2040s. It is remains to be seen whether the current energy reforms will help Mexico to arrest the decline in oil and gas production. Amount of liquid remaining of 9.37 billion barrels with the current production of 2752 kboe/s, the liquid is expected to last for 9.3 years. As for gas, it is expected that it will last for 8.3 years. Most of the production in the Mexico has come from Cantarell and Ku-Maloob-Zaap fields. The production from Cantarell and Ku-Maloob-Zaap fields are expected to be reduced by 300 kboe/d and 200 kboe/d respectively.

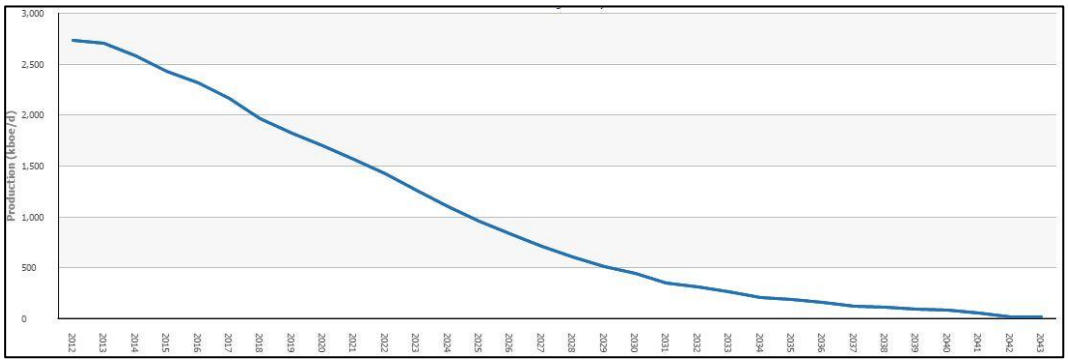

Figure 50: Mexico oil production forecast

In terms of infrastructure to develop the reserves, pipelines have been the medium for oil transportation. There are 3 main branches of pipeline network in Mexico located at South-East, Central and North-East of Mexico. As for gas infrastructures, Mexico has gas transportation networks of 11,500 km transmission pipelines and 28,000 km of distribution pipeline. There are also 3 LNG terminal in Altamira, Costa Azul and Manzanillo. Mexico have gas storage facilities but in order to cater the domestic demand of natural gas, more storage capacity are needed. A vast amount of YTF reserves together with good statistics on the amount of added reserves and drilling activities could help Mexico to continuously exploit their resource potential to the

max. But it is remains to be seen whether their YTF reserves can be fully developed in coming years.

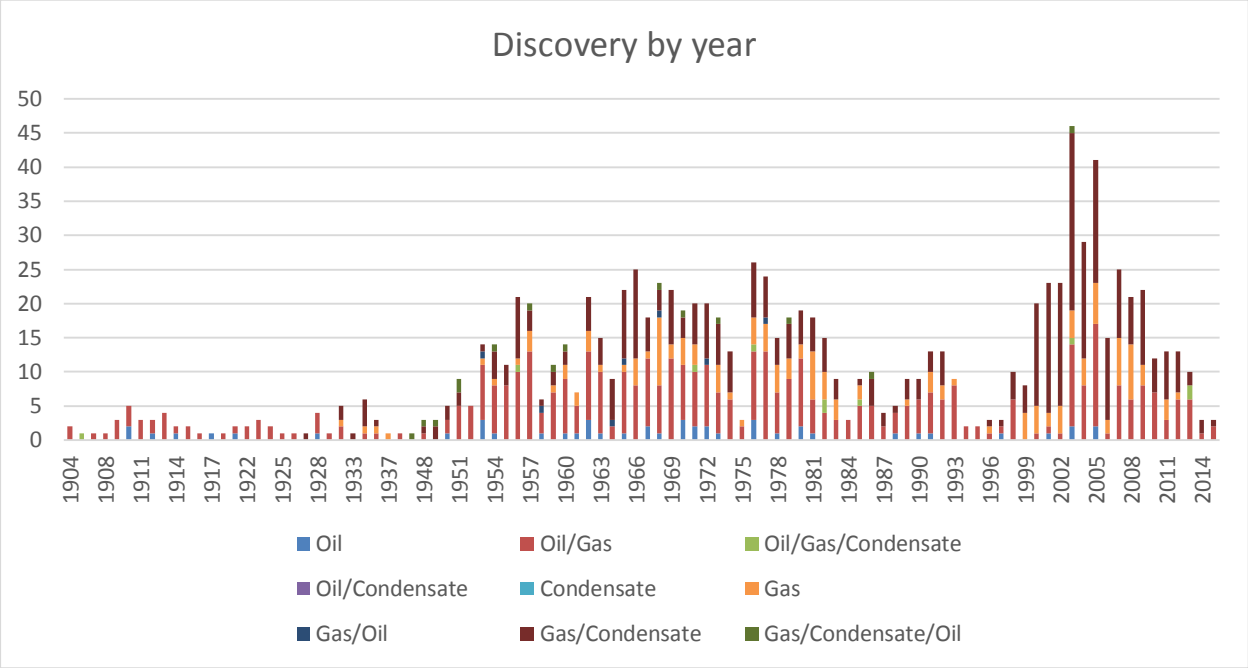

Figure 51: Discoveries by year in Mexico

- Probability of discovery in Burgos Basin

Table 22: Burgos Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	The main type of depositional environment is marine with some of the well penetrate transitional type. The sub-depositional environment is dominated by the marine delta.	1.0
	Effective pore volume	The P50 value of the depth, porosity and permeability are 2000km, 19% and 200md.	0.9
Probability of trap	Effective seal mechanism	Most of the play area have simple seal with unconformable as top surface and no bottom side. The structural type is either anticline or fault.	0.9
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 1.25%.	0.7
		Mostly contain type II/III kerogen.	0.9
		Average R_o of 1%.	1.0
		Average T_{max} of 453 ℃	1.0
	Migration type and Timing	The average trap age is 105.2 MMyear while the average age for petroleum migration is 81.8 MMyear.	1.0
		The type of migration is mainly vertical. It migrates through the faults with salt domes – few kilometers of migration.	0.7
Probability of retention	There are fault reactivation after petroleum migration into the reservoir rock but no clear evidence on the connection of the trap to the hydrocarbon.		0.7
	Probability of discovery		**0.25**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion
34%	2.21	84%	0.743

Local Content	13% in exploration phase. 25% in production phase with expected increment of 35% in 2025.

Table 23: Economic Analysis in Mexico

Field Reserve Sizes	Reserve	Oil Price	NPV Government	Government Take	NPV Contractor	IRR	PIR
Very Small	10	40	82.598	0.837	134.461	0.131364	0.750895
		60	147.924	0.801	222.261	0.206173	1.344764
		80	212.820	0.785	310.490	0.265948	1.93473
		100	277.716	0.776	398.720	0.316768	2.524695
		120	342.613	0.770	486.949	0.361219	3.11466
Small	25	40	352.895	0.831	260.658	0.172626	0.526583
		60	575.438	0.845	425.739	0.248913	0.86008
		80	798.947	0.852	589.854	0.310575	1.191625
		100	1022.456	0.855	753.969	0.363462	1.52317
		120	1245.965	0.865	918.084	0.410025	1.854715
Medium	50	40	743.589	0.788	587.799	0.212229	0.683487
		60	1198.058	0.771	921.424	0.294169	1.071423
		80	1652.528	0.764	1255.049	0.362005	1.45936
		100	2106.997	0.759	1588.675	0.420328	1.847296
		120	2562.322	0.756	1921.444	0.470666	2.234237
Large	100	40	1690.631	0.803	1341.018	0.235072	0.912257
		60	2665.059	0.827	2065.661	0.319258	1.405212
		80	3647.288	0.838	2782.504	0.384409	1.89286
		100	4629.832	0.844	3499.031	0.439687	2.380293
		120	5612.376	0.849	4215.558	0.488088	2.867727
Very Large	250	40	4327.447	0.802	3454.887	0.281578	2.236173
		60	6772.197	0.826	5257.375	0.374287	3.402831
		80	9228.301	0.837	7048.508	0.447035	4.562141
		100	11684.406	0.844	8839.641	0.508948	5.72145
		120	14140.510	0.848	10616.774	0.553658	6.871698

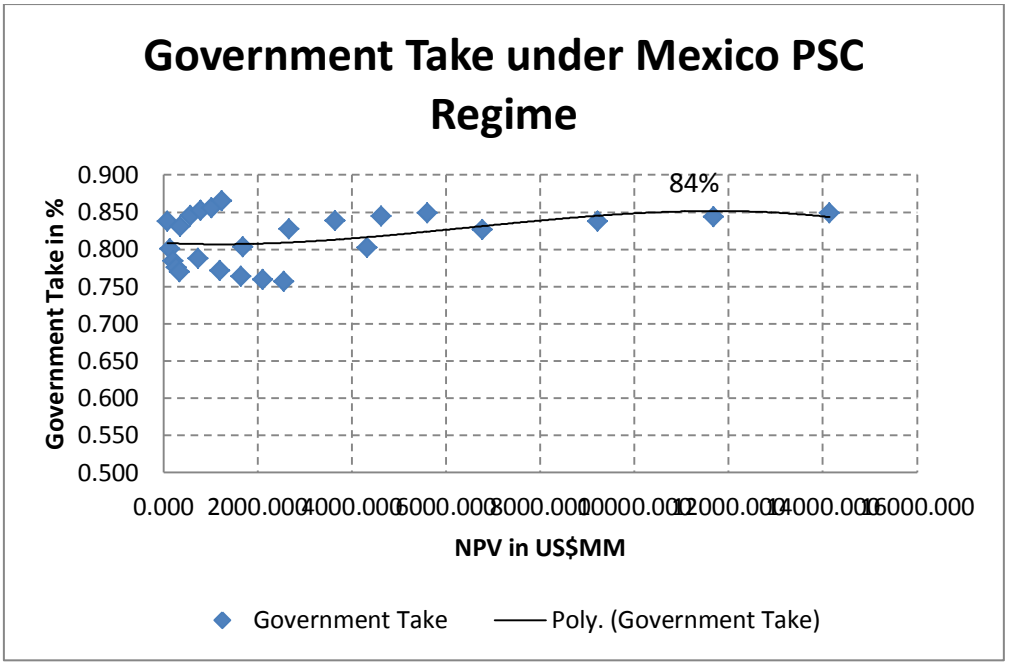

Figure 52: Government take in Mexico

- Fiscal Terms

Mexico prefers to use PSC model in the first two contracts released by them which are contract for shallow water and onshore conventional. The total government take in Mexico based on the shallow water contract is around 84% (Figure 52). This percentage is quite high as compared to the other countries. However, Mexico also has a good internal rate of return of 34%. In comparison with the average of the frontier region of 42%, Mexico can be considered as having a good internal rate of return. In the new shallow water contract, the IRR threshold is expected to be more than 20% as in previous contract. Moreover, the P/I ratio of 1.39 is among the highest in frontier region. Investors are expected to generate profit of 39% higher in comparison with the initial investment. The duration for the contract offered is expected to be 25 years with the investors can request to prolong the contract period in order to start enhanced oil recovery process. In the exploration stage, investors are only given 5 years with 2 years option of extra period. Other than that, they are also expected to offer technology transfer with the local companies. The adjustments made to the IRR threshold is one of the improvement expected to be made by Mexico in

order to produce an attractive fiscal regime. Wood Mackenzie expects the terms will be modified in order to compensate for higher exploration risks.

- Local Content

The local content requirement in Mexico for exploration phase is expected to be at 13% and 25% for production and development stages. Mexico has all the experiences when operating in shallow/easy areas but the investors/contractors are expected to give trainings to the locals and provide technology transfer to the local companies. Other components that are included in calculating the percentage of local content in Mexico are goods, labour, services and infrastructures. Contractors are expected to hire local employees for the technical and managerial positions in each contract. Other than that, contractors are also required to choose local goods if the price, quality and delivery time are the same as in the market. With the experience of the oil and gas companies together with the low local content percentage in Mexico, it is good for the investors to invest in Mexico.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
14		• Shallow water • Onshore conventional

- Infrastructure

Pipeline is the main method for the transportation of oil in Mexico. It consists of three networks which are:

- **South-East**: From Región Sur fields and the offshore Bay of Campeche fields to the Minatitlán refinery and the adjacent port of Coatzacoalcos on the Gulf Coast.
- **North-East**: From Cadereyta refinery at Monterrey to southern producing fields.
- **Central**: From Tampico-Misantla and Veracruz basins to Salamanca and Tula refineries.

Mexico have six refineries as in 2015 as has been reported by Wood Mackenzie, operating at 70% of their capacity. The refineries together with their capacities are shown in the table below.

Table 23: Mexico refineries

Operator	**Refinery**	**Location**	**Capacity, kboe/d**
PEMEX	Cadareyta	Nuevo Leon	275
PEMEX	Ciudad Madero	Veracruz	190
PEMEX	Minatiltan	Tabasco	335
PEMEX	Salamanca	Guanajuato	245
PEMEX	Salina Cruz	Oaxaca	330
PEMEX	Tula	Hidalgo	315

As for gas infrastructure, there are also gas pipelines, LNG terminals, gas storage and processing facilities. The pipeline system consists of 11,500km of transmission and 28,000km of distribution pipelines. The pipelines in the southeast region are used to transport the gas for the locals. There are also network in Northeast region known as the Natural Gas Trunkline System. As for the Northwest, they have isolated network where they import gas from US. As in 2015, there are 3 LG plants in Mexico located

in Altamira, Costa Azul and Manzanillo. The storage and processing facilities are limited. The high demand of natural gas in Mexico shows that they need to expand their storage capacity. As for processing facilities, there are 12 in the country with 8 are in Southern part and the remaining four are n Nothern area. The infrastructure for oil and gas in Mexico is shown in figures below.

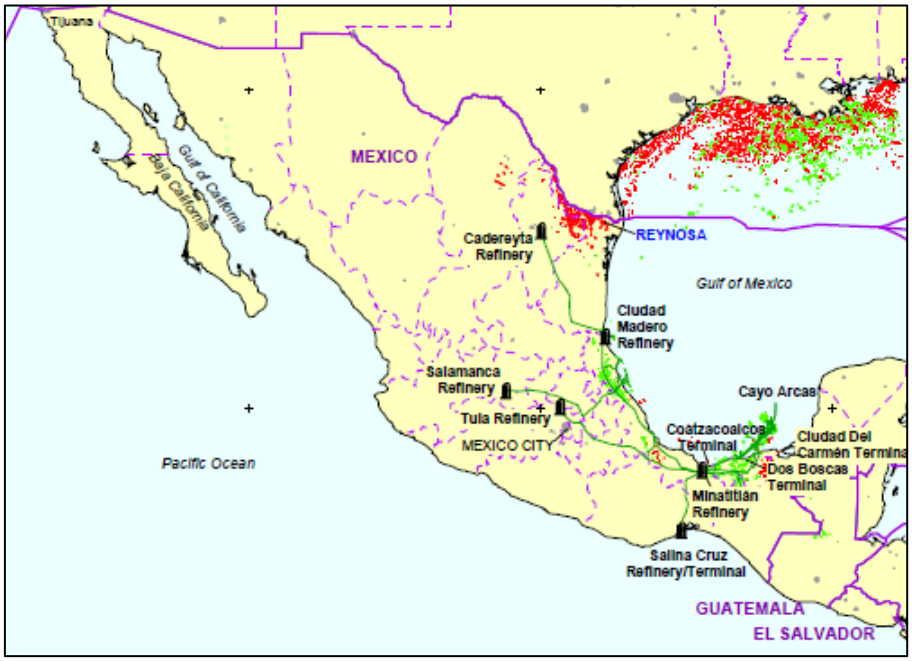

Figure 56: Mexico oil infrastructure system

Figure 54: Mexico gas infrastructure system

- Number of open and farm-in opportunities blocks

In the shallow water opportunities announced by Mexico, there are 14 blocks are set to be offered for bidding. All of the blocks are in the exploration stage and are located in PEMEX current acreages. Most of the blocks are located around the Litoral De Tabasco, Cantarell and Ku-Maloob-Zaap Fields. Some of the blocks are Nak, Mison, Pokoch, Ichalkil, Xulum and Hokchi. Mizton is the block with the most 2P reserves which is 70 mmboe followed by Hokchi (67) and Pokoch (46). Tecoalli and Xulum are blocks with the lowest 2P reserves of 18 mmboe. While for the onshore conventional opportunities, the number of fields ready to be offered are 26 fields with a total of 68 mmboe of 2P oil and gas reserves. All of the fields are located aroundI Burgos, Tampico-Misantla and Salinas-Sureste Basins. In Burgos Basin area, gas and condensates are expected to dominate while Salinas-Sureste Basin is an aea with oil with an associated gas. Mexico has divided the fields into two types which are Type One and Type Two. Type One is considered as the field with less than 100 mmboe. For the onshore conventional opportunities, there are around 75% of fields considered

as Type One according to Wood Mackenzie. These Type One fields are targeting the Mexican companies and small oil and gas players. For the Type Two fields, there are only 4 fields with reserves of more than 100 mmboe. The total amount of 2P reserves in these areas are around 1.6 Bboe. Type Two fields are targeting the juniors and independent companies to go for the bidding process. There are also 9 fields in Burgos Basin expected to be offered all of them are producing except for the Anahuac field. Overall, the amount of opportunities in Mexico is really big. It is up to the investors to consider which type of areas they are interested to do the bidding.

- Bid Round

Currently, there are two bid round happening in Mexico which are for shallow water and onshore conventional regions. For shallow water region, the bidding process is expected to end in August 2015 with the bid winners announcement and contract signing are expected to be in September and November respectively. For companies who are interested to do the bidding, they have to pay USD350,000 for the data access and USD18,000 to participate in bidding process. There are few requirements need to be met by the investors:

  - Technical requirements
    - Involve in at least 3 upstream projects from 2010 to 2014.
    - Have a net production of 10 kboe/d between 2010 and 2014.
    - Experience employees.
    - Meet HSE standards.
  - Financial requirement
    - Total assets of at least USD 10 billion.
    - Have at least USD 1 billion in shareholder equity
  - Other considerations

For the onshore conventional areas, the bids are due in December with the bid round winners and constract signing are expected in December and February 2016 respectively. Companies are required to pay USD 165,000 for data room access and USD 18,000 to join the bidding process. The requirements for the bidding process;

- Technical
  - 10 years' experience
  - Good HSE management
- Financial
  - Total assets of at least USD5 million per bid for Type One fields
  - Total assets of at least USD200 million per bid for Type Two fields

IV. Country Risk

Sub-components	Rating	Description
Political	2.8	• Moderate growth stability in Mexico is not enough in order to solve poverty and employment problems. • The current President of Mexico, Enrique Pena Nieto is a business minded person and would like to increase nuber of foreign investments in Mexico. • The reforms in Mexico were agreed by the three main political parties – Pact for Mexico. • The corruption problem in Mexico is somehow decline with the implementation of the reforms but only in short to medium term. It is expected to affect the investment in a long term period.
Economic	4.1	• The diversified economy in Mexico has been helped by the monetary policies, broadly orthodox fiscal and ever-expanding network of free-trade agreement. • But the growth in the past 12 years has been disappointed especially under the regime of Vicente Fox. • Since then, the economy of Mexico has started to develop again but in 2008 (US recession), their economy was again affected. • However, after the energy reforms, IHS expects the growth to be in between 3%-4%. • But other than the reforms, it is believed that the Mexico is not doing enough in improving their economy by attracting foreign investment and until then, the economy in Mexico will largely be affected by the US business cycle.
Security	2.6	• The most serious problem in Mexico is related to the drug activities. • Other than that, the crimes level is high in the states such as Guerrero, Michoacan and Tamaulipas. • Some of the examples of the crimes in Mexico are armed robbery, kidnapping, taxi robberies and etc. • The kidnapping problem is the most serious in the state of Baja California. • The drugs cartel gangs in Mexico is slowly turn into the small criminal gangs and is expected to be a real threat for companies that has decided to do the investment in Mexico.

4.1.6 Myanmar

I. Upstream Environment and Amount of Resources.

Table 24: Summary of Myanmar Upstream Environment

Population and GDP	Reserve	Production (2014)	Players	Export
•Population: 65.38 million •GDP: $ 65.9 billion •GDP/capita: USD1008 •GDP growth: 6.5%	•Oil: 2.3 Bboe •Gas: 1.7 Bboe	•Oil: 16 kboe/d •Gas: 240 kboe/d	•PTTEP •Daewoo •PetroVietnam •Petronas •Chvron •MOGE	•80% of the gas produced are exported to Thailand.

- Upstream Environment

The oil and gas industry in Myanmar has been dominated by the state owned company, Myanmar Oil and Gas Enterprise (MOGE) due to the economic sanctions put on them. But in 2011, the sanction on the energy sector has been lifted and since then, Myanmar has started to hold bidding and licensing rounds. The domestic energy demand is expected to increase following the lifting of the sanctions. The production in Myanmar has been dominated by gas with 90% of the production consist of gas. 80% of the total gas produced will be export to Thailand and the remaining gas will be exported to China. The problem regarding the maritime border between Bangladesh and Myanmar has been resolved and it allows the exploration activities in the area to be continued and CNPC will start the exploration in AD-6/8 block. Wood Mackenzie expects the offshore exploration to be dominated by PTTEP, Daewoo and PetroVietnam. The first discovery in Myanmar was made in 1864 where they struck oil with associated gas. The discoveries after that have been in a mix. They have struck oil, gas and also condensates. But in the past few years, the discoveries have been dominated by gas. In 2007 alone, there were 4 gas discoveries made in Myanmar.

- Yet to find reserves

Although gas has been dominating the production in Myanmar, USGS has estimates that there are around **2.3 Bboe** of undiscovered oil in the country – 1.8 Bboe more than Malaysia. With the remaining reserves of 0.07 Bboe and 10.86 tcf of oil and gas, the liquid and gas in Myanmar can only last for 12.1 years and 18.8 years respectively at the current production rate. Gas consists of 97% of the remaining reserves and out of 0.07 Bboe remaining, 60% of it is in the Yetagun Field. For the past 5 years, Myanmar have successfully added around 292 mmboe of new reserves. 2011 is the year where majority of the new reserves were discovered – after the economic sanction has been lifted (Figure 55).

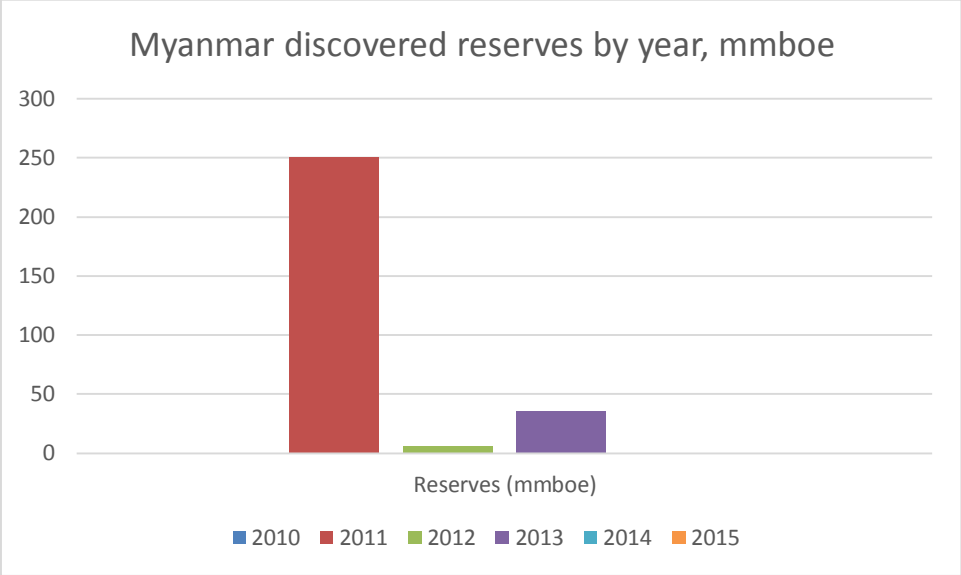

Figure 55: Myanmar discovered reserves in the past 5 years

The exploration activities have increased since the sanction was lifted back in 2011. The technical success rate is increased after 2011 – helped by the increase in the expertise from other bigger oil and gas firms (Figure 56).

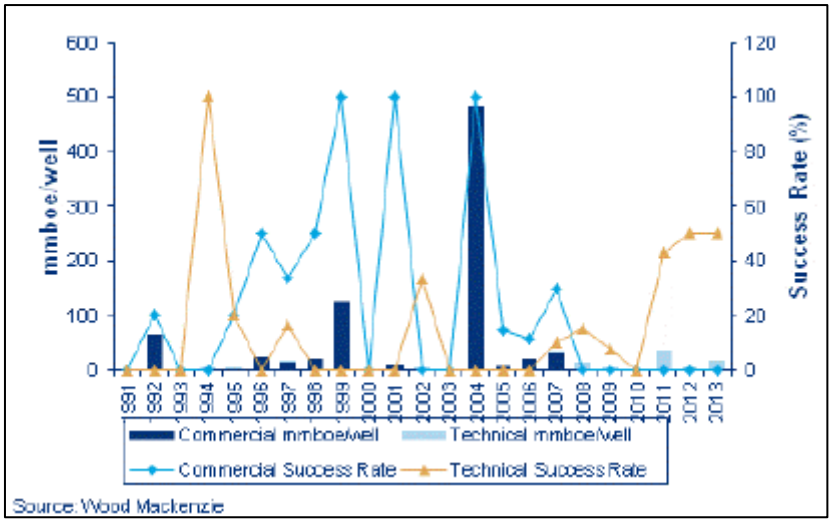

Figure 56: Myanmar technical and commercial success rates

As being estimated by Wood Mackenzie, the liquid production in Myanmar is going to decrease. In order to arrest the decline, EOR has been implied but only sees limited success. As for gas, the Shwe and Zawtika projects are expected to increase the gas production to 2.0 bcf/d in 2016. In terms of remaining reserves, PTTEP holds the largest volume of reserves which is around 700 million boe followed by MOGE, Daewoo and Petronas Carigali (Figure 57). PTTEP migt have interests in large gas projects but Total and Petronas are also building up the position in prolific Yadana and Yetagun fields respectively. To conclude, the prospect in Myanmar is quite big. They have all the facilities required to commercialize the gas. With the EOR program is already in place together with the increase in IOC participation through licensing round, the oil production could be increased.

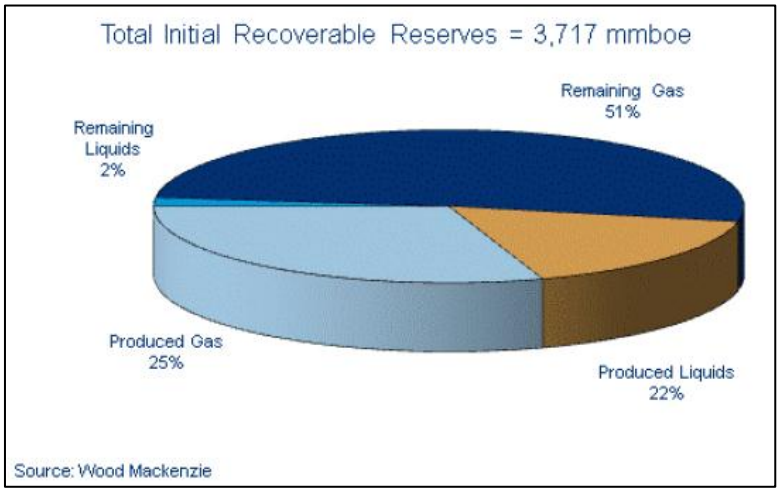

Figure 57: Remaining and Produced Liquid and Gas in Myanmar

- Probability of discovery of Moattama Basin

Table 25: Moattama Basin POD

	Criteria	Description	Probability value
Probability of reservoir	Presence of reservoir facies	The main type of depositional environment is marine with some of the well penetrate transitional type. The sub-depositional environment is dominated by the shallow marine.	1.0
	Effective pore volume	The P50 value of the depth, porosity and permeability are 1490km, 24.5% and 350md.	0.95
Probability of trap	Effective seal mechanism	Most of the play area have simple seal with unconformable as top surface and no bottom side. The structural type is either anticline or fault. The seal mechanism are mostly shale and clay.	1.0
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 1.42%.	0.7
		Mostly contain type I/II kerogen.	1.0
		Average R_o of 0.615%.	0.85
		Average T_{max} of 432 ℃	0.6
	Migration type and Timing	The average trap age is 33.9 MMyear while the average age for petroleum migration is 5.33 MMyear.	1.0
		Unknown	0.5
Probability of retention	Reactivated faults with compression in the Miocene-Pliocene ages.		0.7
	Probability of discovery		**0.119**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion
38%	1.64	75%	0.824

Local Content	25% rising to 75%

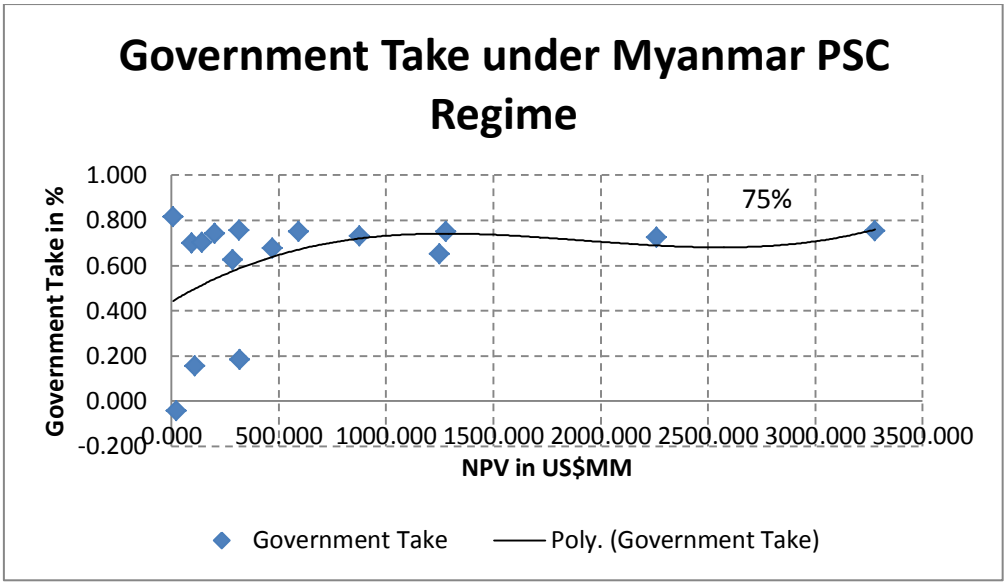

Figure 58: Government take in Myanmar

- Fiscal Terms

After the economic sanction has been lifted, Myanmar have been actively involved in the licensing and bidding round. For this analysis, the fiscal terms for deep water has been chosen since Myanmar have decided to develop their gas resources. From the calculation made, the government take in Myanmar is 75% (Figure 58), which is in the average zone of the government take of the world. However, after considering the state participation of 20%, the contractor is expected to have an 11% share of the whole project. Although the contractor's share is not so high, the internal rate of return is quite good. It is almost the same with the average of the frontier region of 42%. With a good IRR, investors are expected to reach breakeven at a much faster rate. Myanmar P/I ratio is not so high when it is compared with other frontier countries. The average value for frontier region is 1.8. But, if the value for P/I ration is greater than 1, it can already be considered as good.

Under this fiscal terms, investors are required to pay signature bonus of USD 2 million. There are also other bonuses payable by the investors which are discovery and production bonuses. Investors are also expected to pay training fee of USD 50,000 during the exploration stage. Profit sharing is based on the average daily production. It varies from 20% to 45%. But in the calculation of the government take, the worst case scenario is chosen where 20% contractor's profit share is selected. There is also domestic supply obligation need to be followed by the investors. They are expected to supply 20% of their profit oil share and 25% of their profit gas share at 90% of the market price. Overall, the fiscal terms in Myanmar can be considered as average. The high state take might be a problem for them to attract investors but the high IRR together with small amount of signature bonus could be a decisive factor for the investors.

- Local Content

  The percentage of local content in Myanmar as has been written in the SEZ law Section 11 is 25% rising to 75%. Employers are required to give priorities to locals when recruiting new employees. In the first five years, Myanmar expects the investors to hire 25% of locals from total number of employees in their companies. The percentage will rise to 75% in the 11^{th} year of the companies in Myanmar. Investors are also needed to provide trainings, education and technical knowledge to the locals for the developments in Myanmar. Under the fiscal terms provided by Myanmar, investors are expected to supply oil and gas from their profit shares at a 10% lower price than in the market. Other than that, the local employees are expected to receive the same amount of salary as the foreign workers in the companies.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
20	5	• Third onshore round – unconfirmed • Second offshore round - unconfirmed

- Infrastructures

Myanmar have the facilities to fully develop their oil and gas resources. As in 2015, Myanmar is reported to have three refineries namely Chauk (6000 bbl/d), Thanbayakan (25,000 bbl/d) and Thanlyin (20,000 bbl/d). A pipeline between Myanmar has been completed in 2013 with 803 km in length enable China to transport oil to Myanmar. As for the gas to be transported, 409 km of gas pipeline from Yadana Field to the border of Thailand has been built with as capacity of 700 mmcfd with expected increase to 1000 mmcfd when the compression is applied. Other than that, the gas from Block A1 and Block A3 will be transported to China through a new 803 km pipeline. Another gas project in Block M9 will also be supported with a 240 km pipeline to the Daminseik and will be directed to Ban-I-Tong to be transported to Thailand.

Table 26: Myanmar oil pipeline network

Pipeline	Operator	From	To	Length, km	Diameter, in
Mann to Thanlyin	MOGE	Mann	Thanlyin	480	10
Yenangyaung to Chauk	MOGE	Yenangyaung	Chauk	65	10
Kyauk Phyu to China Border		Kyauk Phyu	Muse	803	30

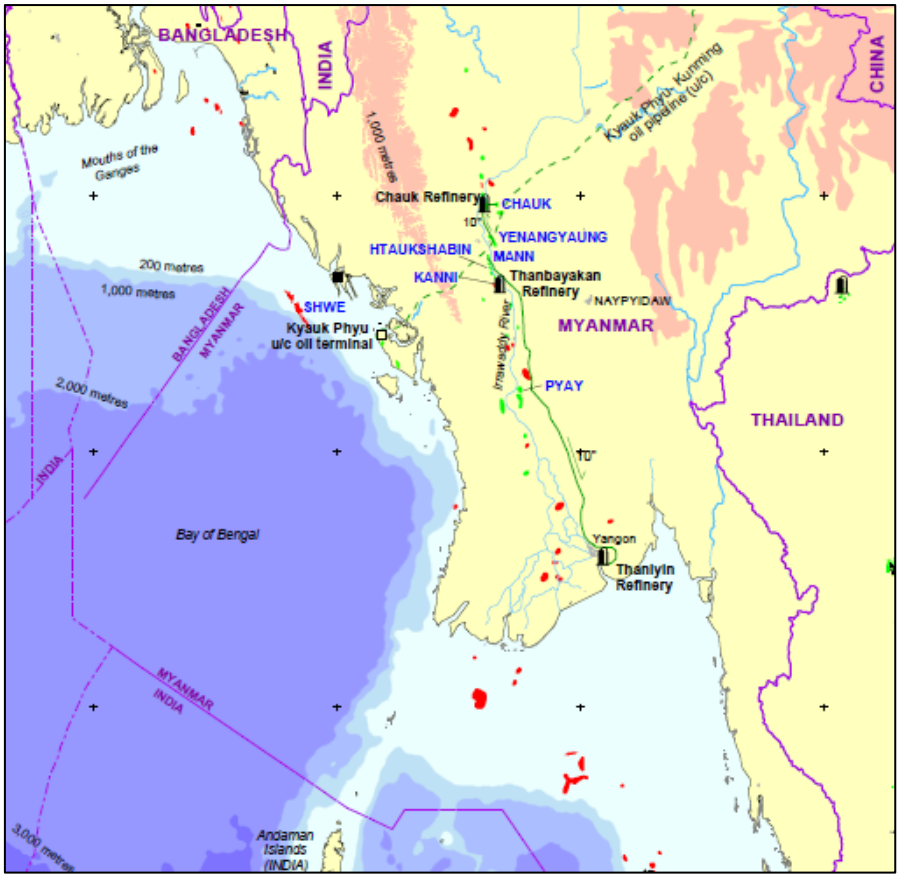

Figure 59: Infrastructure map in Myanmar

- Number of open and farm-in opportunities blocks

As for now, there are 5 farm-in opportunities in Myanmar. Two of them are in the Rakhine Basin and 3 of them are in the Moattama Basin. All of them use PSC as the contract model. One of the blocks is in the evaluation/studies stage operated by Ophir. Two of the blocks are in the surface exploration/drilling stage and the last two are in the development stage. All of the blocks are located offshore with 3 of them are in deep-water region. The blocks in the farm-in opportunities are block AD-03, blocks A-6, block M-03, block M-09 and block M-11. As in 2015, there are 20 open blocks identified by IHS in Myanmar. Most of the blocks are located offshore and in deep-water area. Half of the blocks are either in the Bengal Deep Sea Fan Basin of the Rakhine Basin. In comparison with other frontier countries, the number of the open blocks available in Myanmar is quite high. All of the resources in the blocks are conventional resources.

- Bid Round

  Myanmar just held first offshore round in 2013 where 11 shallow water and 19 deep-water blocks have been offered. BG Groups and Woodside have been awarded with four blocks followed by Shell and Mitsui with three blocks. Other companies that have won the bid round were ConocoPhillips and Statoil, Reliance, Oil India, Berlanga Holdings, Chevron, TOTAL, Ophir and Transcontinental group. Myanmar is expected to hold Third Onshore Round although the date is still unconfirmed. It was originally set in February 2014 but due to few circumstances, it was delayed. In this round, the unconventional blocks are expected to be offered for foreign investment. Other than that, the extra blocks from the second round are also expected to be offered. Other than that, Myanmar is also anticipated to hold Second Offshore Round. The number of blocks to be offered are quite big which is around 20. But in October 2014, they announced that only 9 blocks will be offered most probably in mid-2015.

IV. Country Risk

Sub-components	Rating	Description
Political	2.5	• Myanmar political environment has changed since 2011 when Thein Sein took the office. • There are supports from the government and military for the politics in Myanmar to move into a new era. • The rising freedoms of speech and anti-Muslims hatred could disrupt the political stability in Myanmar. • There are also fighting between military and insurgent groups. • Military's refusal to sign ceasefire agreement could result in a delay general election.
Economic	2.7	• Myanmar economy has growing slowly in the past decades due to poor military administration and international sanction. • The lifted sanction has given Myanmar a new chance of improving their economy by developing their natural oil and gas resources. • With its location around India, China and South East Asia, the time is right for Myanmar to develop its resources due to huge gas demand from these countries. • Western investment has increased after the conference between Myanmar and western countries and after Myanmar clear up their external debts. • Overall, Myanmar still has a lot to do in order to see a strong economic growth. • Weak administration and corruption problems have to be solved for the economy to grow strongly.
Security	2.4	• Myanmar has been affected by the presence of the armed ethnic groups. • The effort made by the government to stop the activities has been disrupted by the military group who refused to sign ceasefire agreement. • The vast natural resources together with the narcotics, jade and tiber trades have made the effort to stop the fight to fail. • The anti-Muslims movement by the Buddhist monks has also increase in Myanmar recently.

4.1.7 Mozambique

I. Upstream Environment and Amount of Resources.

Table 27: Summary of Mozambique Upstream Summary

Population and GDP	Reserve	Production (2014)	Players	Import
•Population: 25.8 million •GDP: $15.6 billion •GDP/capita: $610 •GDP growth: 7.4%	•Oil: 2.9 Bboe •Gas: 7.7 Bboe	•Liquid: 1 kboe/d •Gas: 75 kboe/d	•Eni •Anadarko •Statoil •Petronas	•Majority of the gas produced are exported to South Africa - 127 Bcf (EIA)

- Upstream Environment

Mozambique is one of the countries identified as East African Rift Play. It is a country that is rich with gas instead of oil. The gas discoveries made in the past few years in Mozambique has made them one of the most prolific country in East Africa. Since 2008, there were 13 discoveries made in Mozambique and all of the discoveries were gas. Most of the gas production in Mozambique have been transported to South Africa. Some of the gas produced however are used for the generation of electricity domestically. As being reported in 2015 by EIA, only 15% of the Mozambique's population have access to electricity. With the prospect of gas found recently, Mozambique has the opportunity to use their natural resources for the generation of electricity given the proper infrastructures available in the country. International Monetary Funds (IMF) has estimated that the economy of Mozambique could see a strong growth in the future if the gas and coal resources are fully developed. They expect the economy to increase by 2% between 2013 and 2023. As in 2015, Eni and Anadarko are the leading companies in Mozambique. They have a combined technical and commercial reserves of more than 11,000 mmboe.

- Yet to find reserves

Mozambique is said to hold a large gas prospect in the country. According to the data released by USGS in 2012, they estimate the oil and gas yet to find reserves to be **2.9 Bboe** and **7.7 Bboe** respectively. This huge amount of gas prospect is supported by the large number of gas discoveries in the past few years in Mozambique. In the past 5 years, over 100 tcf of gas were discovered mainly in Area 1 and Area 4 located in Rvumo Basin and operated by Anadarko and Eni respectively. Anadarko and Eni are in a discussion to form a joint-venture to develop both fields together. But, it took longer than expected for the idea to be materialized and it is afraid that it will affect the economic aspect of the project instead of generating profit. The huge success in Mozambique has been supported by Wood Mackenzie data as shown in the figure below. Both commercial and technical success rates have increased significantly since 2009. The impressive success rates in Mozambique suggests that the drilling operations should be continued in order to fully develop the yet to find reserves in the country (Figure 60).

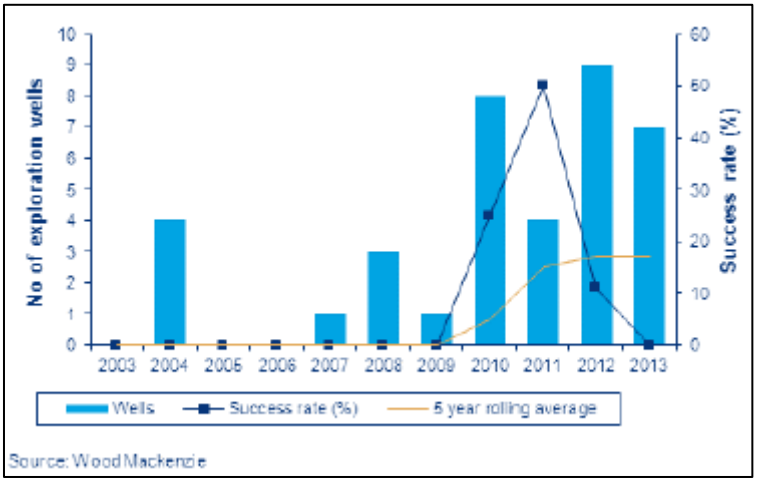

Figure 60: Success rates in Mozambique

The remaining liquid and gas reserves in Mozambique are 0.02 Bboe and 0.45 tcf respectively. At the current production rate, the liquid and gas reserves will only last for 54.8 years and 220.1 years. In comparison to gas, the oil reserve is not too big. But, Statoil and Petronas are currently working on the exploration of the oil fields in the southern part of the Rovumo Basin. Until now, they are yet to make a commercial

discovery but the exploration activities are still continue. Wood Mackenzie expects the exploration that targeting oil to increase in 2014 in other areas in Mozambique. Thus, they estimate that the production of oil to start increasing from 2017 onwards. As for the gas, the unitization program between Andarko and Eni will be the key to the increase in gas production in Mozambique. Wood Mackenzie expect the gas production to start increase from 2022. The partnership with big Asian NOC to focus are vital on the LNG project in the future.

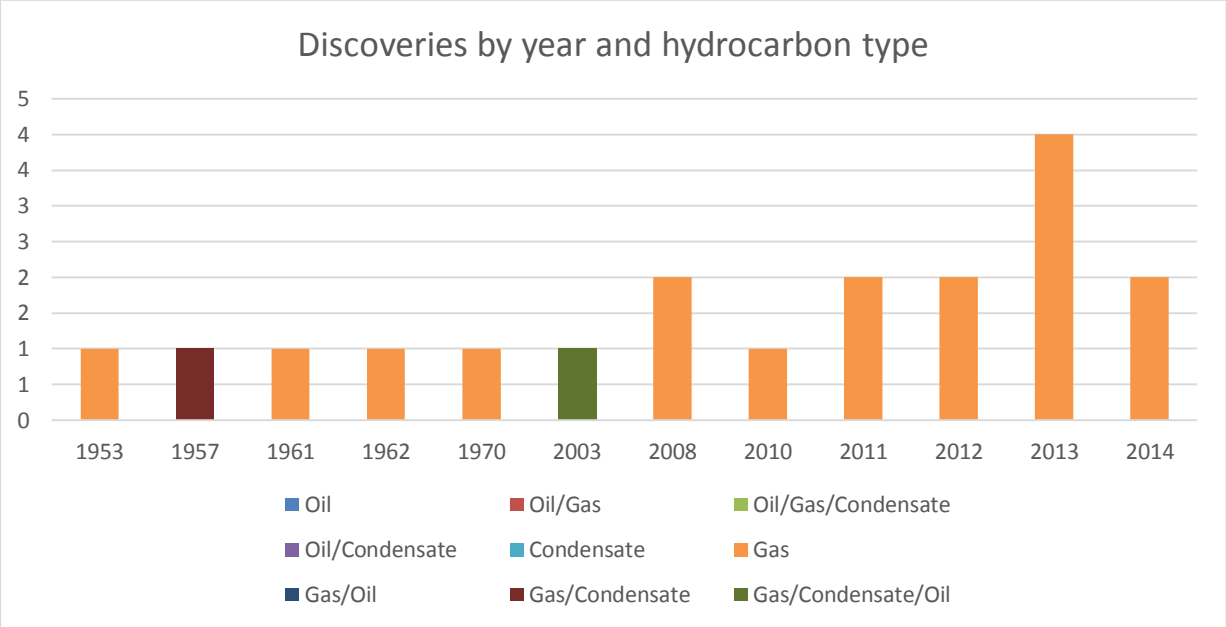

Figure 61: Discoveries in Mozambique

- Probability of discovery

Table 28: Ruvuma Basin POD

	Criteria	Description	Probability value
Probability of reservoir	Presence of reservoir facies	Most of the geologies are with Marine depositional environment with sub-depositional environment of shallow and deep marine with alluvial. There are also terrestrial and transitional depositional environment	0.9
	Effective pore volume	P50 value of porosity and permeability 22% and 900md respectively. The P50 value for depth is 2 km.	1.0
Probability of trap	Effective seal mechanism	A simple seal with unconformable as top surface and unknown bottom side. Contain mostly faults as the structural style. Most of the seal lithology are shale.	0.9
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 4.4%.	1.0
		Most of the reservoirs contain type I/II or II/III kerogen.	0.9
		Average R_o value of 0.82%.	0.9
		Average T_{max} of 429 ℃	0.9
	Migration type and Timing	The average trap age is 165.4 MMyear while the petroleum migration age have an average age of 111.3 MMyear.	1.0
		Mainly vertical migration. Migration in Rovuma basin largely affected by the sandbody between updip and downdip faults.	0.95
Probability of retention	Presence of tilting and faulting tectonic activities after the petroleum migration in the Mesozoic-Cenozoic ages with no knowledge on status of trap connection.		0.8
	Probability of discovery		**0.449**

II. Fiscal Terms and Local Content

IRR	P/I Ratio	Government take	Tax distortion
45%	1.83	69%	0.916

Local Content	No specific percentage but the local content is quite strict.

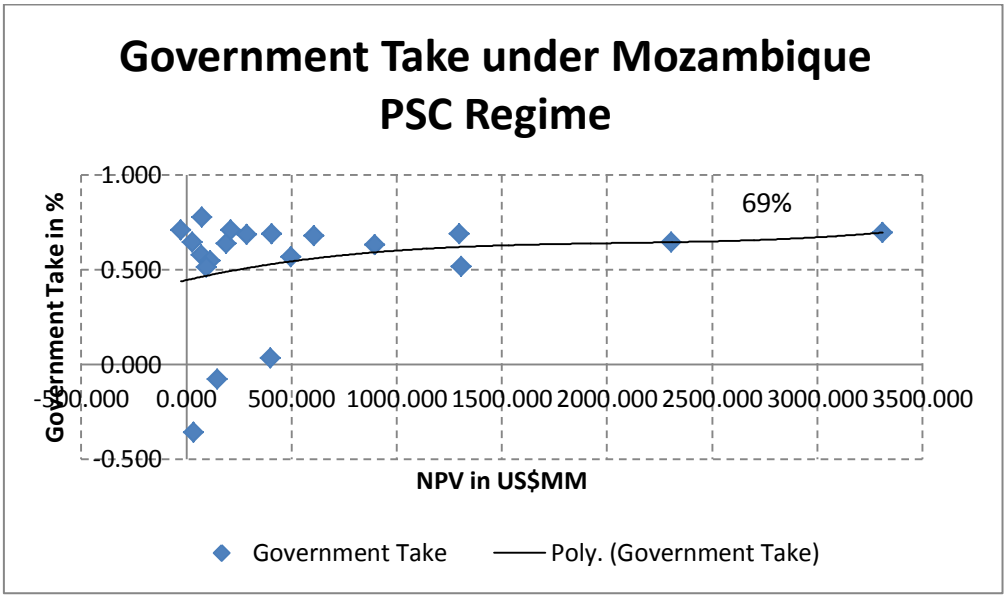

Figure 62: Government take in Mozambique

- Fiscal Terms

As other East Africa countries, Mozambique prefers to use PSC model as their choice of the oil and gas contract system. Mozambique's government take of 69% (Figure 62) is actually favorable for the investors. The low royalty, taxes and state participation rate have contributed to the low government take in Mozambique. In comparison with other countries in Africa, the government take in Mozambique is quite low. Since Mozambique is looking to develop their natural gas resources, a low government take could help them to attract investors from Asian NOC to help them develop LNG infrastructures in the country. Other than that, with a high internal rate of return and P/I ratio, investors can be assured that they are going to gain profits and reach breakeven cost at a much faster rate. The 45% of IRR is the fourth highest rate among the frontier countries identified across

the world. The contractor's profit share is depending on the R-factor ratio. It varies from 40% to 85%. Looking at the P/I ratio of 1.83, investors can expect their profit share to be 65%. It is more than 50% and this percentage can be considered as good for the contractors. However, in the calculation of government take in this report, a contractor's share of 40% was assumed. With a sliding scale based system, this system will favor the government of Mozambique more since a higher R-factor will lower down the contractor's profit sharing in a contract. But if the R-factor is to be between 1 and 1.5, contractor will get quite a high share which is around 75%. Under this regime, contractors do not need to pay any signature bonus. However, there are Annual Training Fee, Annual Institutional Support Fee and Annual Social Support Fee of USD 250,000, USD 400,000 and USD 120,000 respectively.

- Local Content

There is no specific laws regarding the local content requirement in Mozambique. However, there are some policies that are close to local content in the petroleum and mining laws. Companies have to prefer the local products and services when they quality and prices are almost the same as in the market – 10% margin in terms of quality, delivery time and quantity available. Other than that, some percent of the profit generated by companies must be used for the local community programs. However, VAT tax is exempted on the import products only if the product is not available locally.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
2	2	Fifth Licensing Round - Closed

- Infrastructure

In terms of infrastructures for oil, there used to be a 306 km and 289 km pipelines but those pipeline are no longer in use. Most of the liquids produced from the Temane field is transported to the storage facilities in Beira by truck. Other than that, the oil, expected to be produced from Inhassoro field in 2015 will be transported via 20 km pipeline to the processing plant. As for gas, the facilities are quite limited. There is only one pipeline to transport gas from Mozambique to South Africa. Anadarko has planned to have two train with 5 mmtpa LNG development (Figure 63).

Pipeline	Operator	From	To	Length (km)	Diameter (inches)	Capital Cost (US$m)	Capacity (mmcfd)
Pande-Temane	Sasol	Pande	Temane CPF	47	20	50	400
Mozambique-South Africa	ROMPCO	Temane CPF	Sasol Two and Three (Secunda)	865	26	580	460

Figure 63: Mozambique gas pipeline

The discoveries made by Eni will be supported by the second LNG project planned by Mozambique but it will be for domestic use instead of exporting it to other countries. However, none of their partners have experience in LNG development. It is expected that Mozambique is going to have corporate deals in order to develop some LNG plants in the future.

- Number of open and farm-in opportunities blocks

  The number of blocks available in Mozambique is the lowest as compared to other countries analyzed in this report. There are only 2 blocks available for each open and farm-in opportunities. As for farm-in opportunities blocks, the two blocks are in the Funhalouro High Basin and Mozambique Basin. Mozambique basin is one of the two most prolific basin in Mozambique after Rovumo Basin. The name of the blocks are Block Area A and Block Sofala. Both Blocks have been operated by Sasol Petroleum. Block Area A is in the exploration/production stage but the Sofala Block is still in the surface exploration/drilling. Block A is located onshore while Sofala Block is located offshore. Both of them are in land and shelf terrain respectively. As for open blocks, there are also 2 blocks available. The blocks are blocks A-10 and block Mazenga Graben. Both of the blocks are located in Mozambique and Nhachengue-Domo High basins respectively. Block A-10 is an offshore blocks with deep-water terrain while the other block is in onshore and land region. With the new discoveries made in the past few years, the number of blocks offered are expected to increase. Asian NOCs are expected to participate vigorously in the next bidding rounds.

- Bid Round

  After a new framework has been passed by Mozambique a licensing round has been conducted in 2014. The new framework is said to be stricter on the local content requirement. On October 23rd, Mozambique has announced its fifth licensing round with 15 blocks have been offered mainly in Rovumo, Zambezi, Angoche, Pande-Teman and Palmeira basins. The bid was closed on January 20th. The winners of the bid round are yet to be announced by the Government of Mozambique. Since Mozambique just finished its fifth licensing round, it is expected that it will take sometimes for them to hold another bid round. But, investors can also ask for the blocks availability through the direct negotiation with the Instituto Nacional de Petróleo (INP). With the amount of gas reserves found, Wood Mackenzie expects Mozambique to have a regular licensing round – maybe every two years and the focus will be on the open acreages rather than farm-in opportunities because most of the open acreages still do not have any exploration history. The bids are expected to be competitive with IOCs will look to participate in the licensing

round and Asian NOCs are also expected to participate actively in any licensing round held by Mozambique in the future.

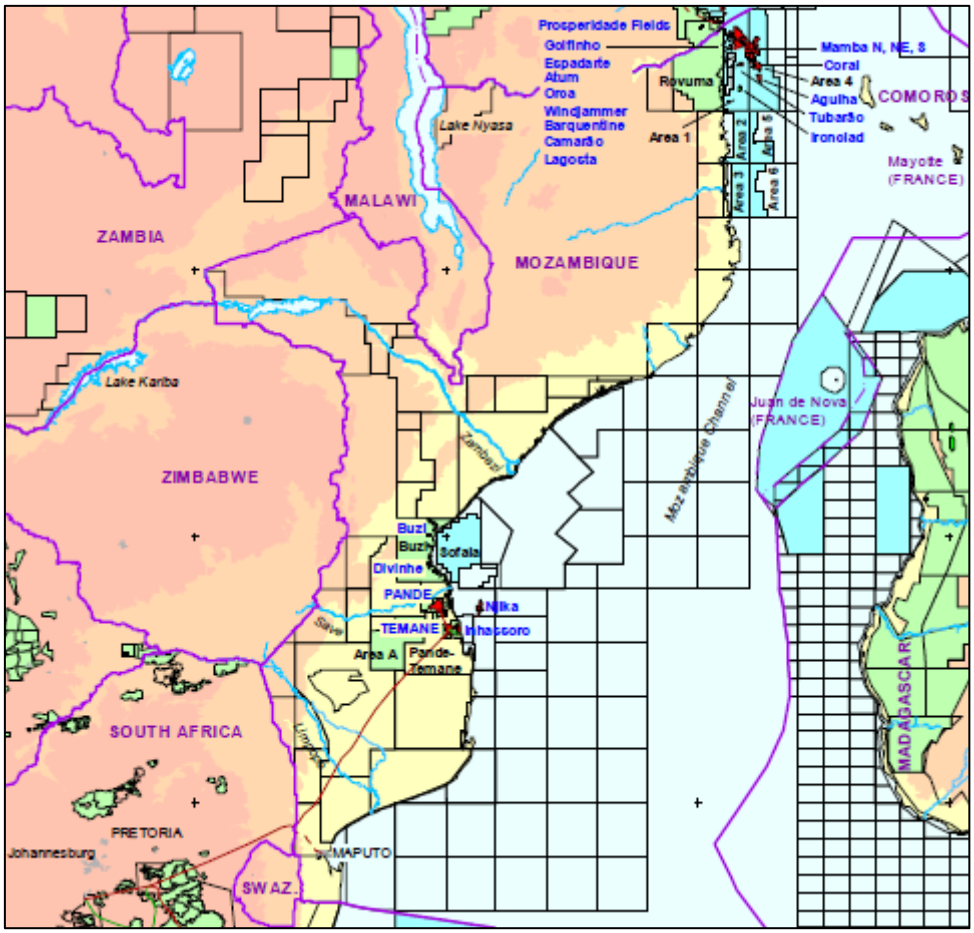

Figure 64: Licensed and open blocks in Mozambique

IV. Country Risk

Sub-components	Rating	Description
Political	2.9	• The former Defense Minister, Filipe Nyusi has been touted as the next presidential candidate for the Mozambican Liberation Front to replace Guebuza. • Guebuza is looking to select the candidate of his choice in order to protect his family business in the country but he do not get many supports from the party. • Nyusi however has been supported by the Chipande who has big influence in the Central Committee. • The selection has shift the political and economic attention to the northern part of the country. • President Nyusi is expected to put the LNG development as the highest priority. • Guebuza is unlikely to retain its influence after he steps down and under Nyusi, FRELIMO is expected to be the dominant party in Mozambique for at least 5 years.
Economic	3.3	• The falling domestic interest rates, resilient credit growth and improvement in the employment sector will result in a strong consumer spending in Mozambique. • The foreign investment for the LNG project is expected to generate a good income for Mozambique. Arounf USD 24 billion will be invested to develop the huge natural gas resources. • The non-oil sector, especially coal is moving downward due to the drop in the commodity prices worldwide. • The deficit in Mozambique is expected to be more than 30% of the GDP in 2015 due to the falling in commodity prices and lack of foreign direct investment. • IHS expects the debt to be thicken and the currency to be 9-11% weaker in 2015.
Security	2.9	• The decision made by the opposition party to rejoin the political process will result in reducing the number of the armed attacks in the country. • The good relationship between its neighbors country reduces the risk of interstate war. • The kidnapping activities is expected to increase outside the Maputo and will pose more threats to emigrants instead of locals. • The piracy problem remains a big issue. It will require the cooperation from all neighbors' countries in order to make sure that the issue could be solved efficiently.

4.1.8 Tanzania

I. Upstream Environment and Amount of Resources.

Table 29: Summary of Tanzania Upstream Environment

Population and GDP	Reserve	Production (2014)	Players	Import
•Population: 49.2 million •GDP: $ 43.6 billion •GDP/capita: $860 •GDP growth: 7.3%	•Oil: 1 Bboe •Gas: 4.03 Bboe	•Oil: 0 kboe/d •Gas: 21.7 kboe/d	•Ophir •Statoil •Exxon Mobil •BG Group	•Oil: kboe/d

- Upstream Environment

As in 2015, there is no oil production and only a small gas production in Tanzania mostly used domestically. The exploration in Tanzania is intensified in the past few years due to the new gas discoveries made in the country. According to PFC, there is around 25 to 30 tcf of recoverable gas found by BG, Ophir, Statoil and ExxonMobil. Similar to Mozambique, there are only 15% of Tanzania's population who have access to electricity. This newly discovered gas could be a key to generate electricity from the natural gas. Deep-water exploration has begun in Tanzania but the first discovery was only made by BG-Ophir partnership in 2010 in Block 1, 3 and 4. Other than that, Statoil-ExxonMobil also made five new discoveries in Block 2 of Tanzania. As can be seen from Figure, all of the discoveries made in Tanzania are gas, which further prove that Tanzania is a gas prone region. For the past 4 years, 16 gas discoveries were made with only one made in 2015 at the moment.

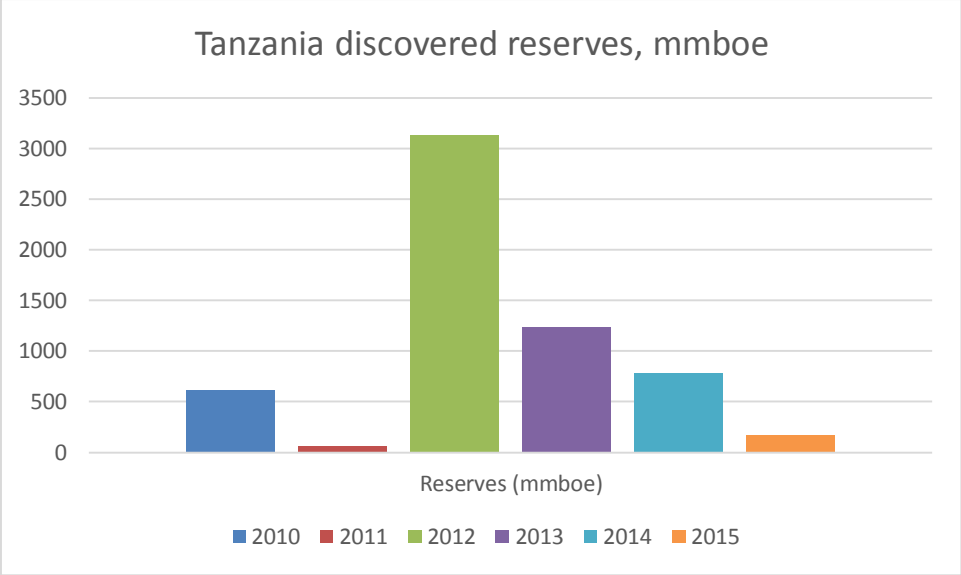

Figure 65: Tanzania discovered reserves in the past 5 years

- Yet to find reserves

According to USGS, as in 2015, there are **1 Bboe** of oil and **4.03 Bboe** of gas yet to discover in Tanzania. The prospect is huge in Tanzania and this is further proven by a big number of new gas discoveries made in the past 4 years – mainly in deep-water region. The exploration success in Tanzania is quite high but it is vital for the investors to know that the geological risk is also high. Petrobas and Ophir have drilled two dry wells in block 5 and block 7. The exploration activities has slowed down a bit in Tanzania since the drop in oil price in late 2014. As can be seen from the figure below, the number of completed wells have reduced significantly in 2014 as compared to 2013 level (Figure 66).

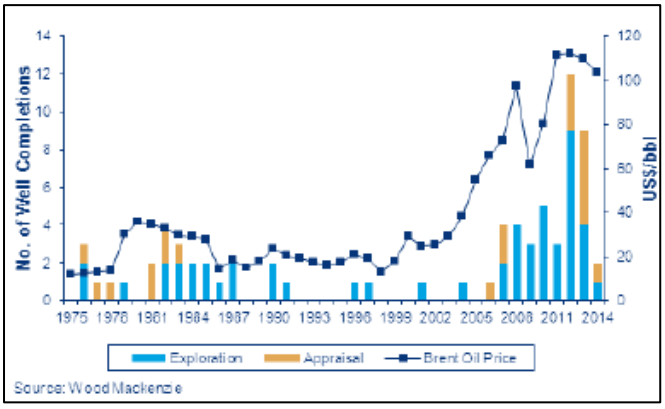

Figure 66: Tanzania drilling activities with oil price

Although the trend is not so good now, Wood Mackenzie expects the exploration activities to keep going in the next few years especially in deep-water areas. Other than that, it is also important to note that the risks associated with the deep-water exploration in the East Africa region is quite high as compared to others due to complex geological structures and depth of the reservoir. As in 2015, BG and Statoil have the highest commercial and technical reserves of 1600 mmboe and 1450 mmboe respectively (Figure 67). But in terms of production, Orca Exploration Group leads the way with 22 kboe/d of gas. There is no oil production in Tanzania. The gas production is at 21.7 kboe/d. With the remaining gas reserves volume at 28.87 tcf, the life of the reserves is expected to last for 608.6 years. But, Wood Mackenzie expect the gas production in Tanzania to increase dramatically from the current rate to 300 kboe/d in 2025. Assuming there is not addition to the current remaining reserves, the gas will only last for 4.4 years. Thus, it is vital for Tanzania to keep continue with the exploration activities in order to keep adding the gas reserve to the country itself. Since 2012, the volume of added reserves for each year have been declining. In 2015, as in June 2015, the added volume is only 172 mmboe compared to 3000 mmboe they added in 2012. The key for Tanzania to add the gas reserves is to fully develop their newly found gas in Block 1, 2, 3 and 4. The additional of 30 tcf of the newly discovered reserves will prolong their gas life to at least 4 more years. BG and Statoil has planned an LNG project consist of two train, 10 mmtpa LNG plant. The decision of the joint-venture is yet to be made and expected to prolong until 2016. Wood Mackenzie expects the result of Tanzania LNG project to be four trains, each with 5 mmtpa. Other than that, Tanzania is also planning to have a pipeline that will be extended to Mombasa, Kenya. To supply the gas domestically, Tanzania have two main plants to convert gas to electricity which are Songo Songo and Mnazi bay. Songo Songo is already in operation with Mnazi Bay is expected to start operation by 2017.

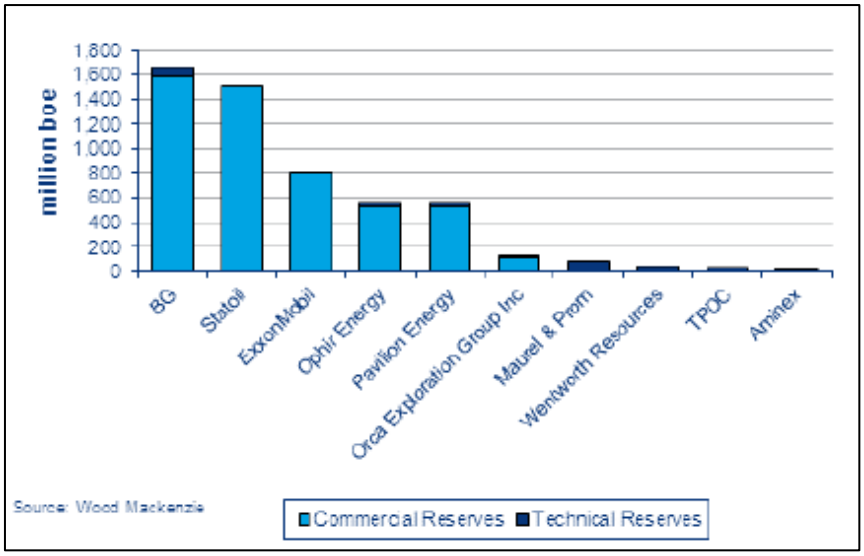

Figure 67: Reserves by company in Tanzania

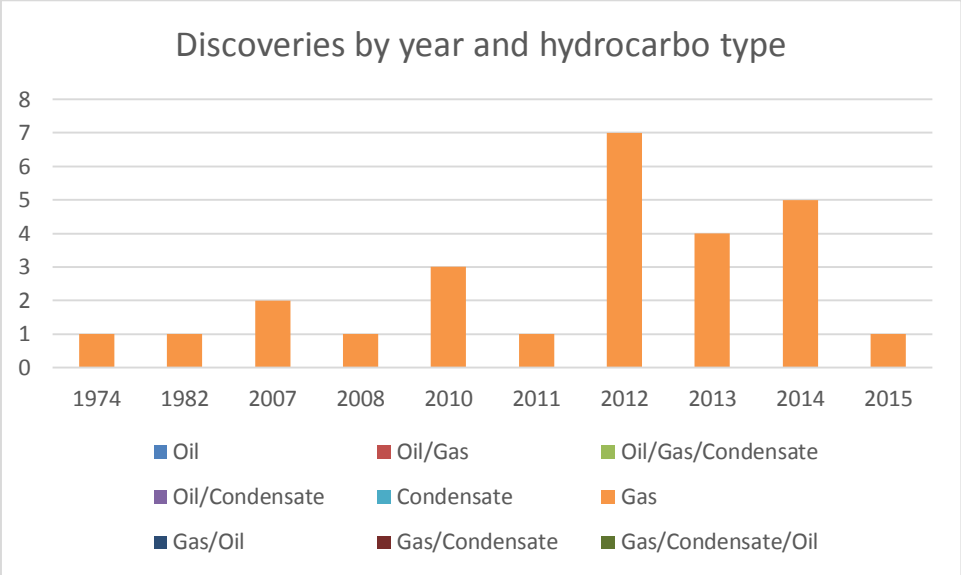

Figure 68: Discoveries in Tanzania

- Probability of discovery in Rovuma Basin

Table 30: Rovuma Basin POD

	Criteria	**Description**	**Probability value**
Probability of reservoir	Presence of reservoir facies	The main type of depositional environment is terrestrial with some of the well penetrate marine type. The sub-depositional environment is dominated by the lacustrine and fluvial.	0.9
	Effective pore volume	The P50 value of the depth, porosity and permeability are 2500km, 18.8% and 1100md.	1.0
Probability of trap	Effective seal mechanism	Most of the play area have simple seal with unconformable as top surface and no bottom side. The structural type is either fault or depositional pinch out. The seal mechanism are mostly shale.	0.9
Probability of charge	Quality and maturity of source rock	Have an average TOC content of 18.51%.	1.0
		Mostly contain type I/II or II/III kerogen.	0.9
		Average R_o of 0.837%.	0.9
		Average T_{max} of 444.28 ℃	0.9
	Migration type and Timing	The average trap age is 165.4 MMyear while the average age for petroleum migration is 111.3 MMyear.	1.0
		Lateral migration.	0.95
Probability of retention	There is delta development and onshore uplift after petroleum accumulation. Presence of tilting and faulting tectonic activities after the petroleum migration in the Mesozoic-Cenozoic ages with no knowledge on status of trap connection.		0.8
	Probability of discovery		**0.449**

II. Fiscal Terms and Local Content

2013 Model PSA Terms Deep Water greater than 500m and Lake Tanganyika North

IRR	P/I Ratio	Government take	Tax distortion
14%	1.03	90%	0.574

Local Content	Similar to Mozambique. No specific percentage but have a tough local content requirement.

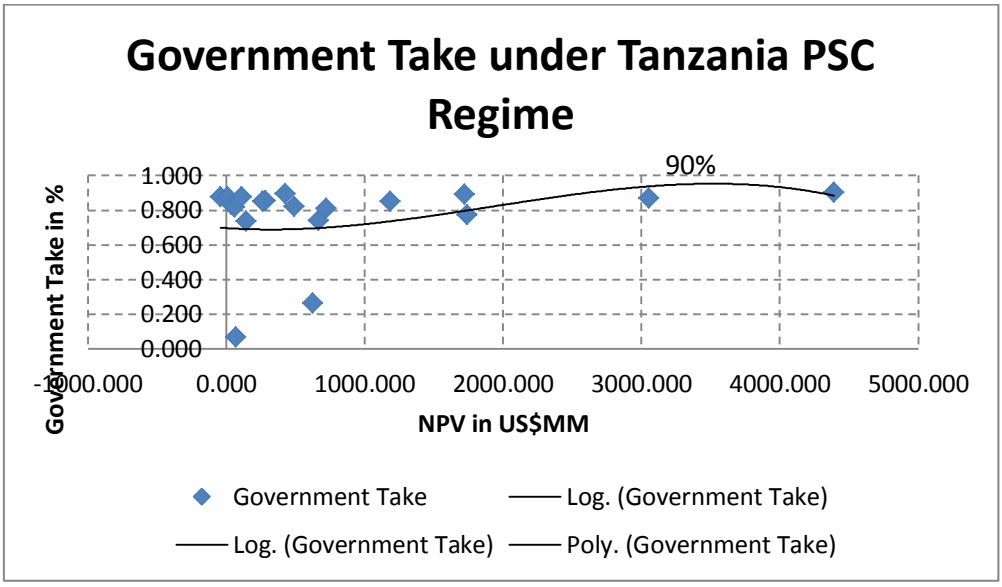

Figure 69: Government take in Tanzania

- Fiscal terms

In 2013, Tanzania has approves a new Natural gas Policy for the development of the gas resources in the country. Looking at the government take in Tanzania, it is the highest among others. Although the royalty rate is low, the total amount of taxes of 55% is quite high as compared to others. The state participation of 25% will further reduce the investor's final take. After consider the 25% of state participation, investors are expected to have only 7% of total profit oil. This percentage is not favorable for the investors and in order to attract more foreign investment, Tanzania ha to lower down the total state and government take. The profit sharing under this regime is between 15% to 40%. In the calculation of the government take, the worst

case scenario is chosen which is 15% of contractor's take. Higher daily production will reduce the contractor's share in the profit split. The income tax in Tanzania is only 30%. But if the internal rate of return goes beyond 20%, an additional 25% of taxes need to be paid by the investors, rising to 35% if IRR exceeds 30%. But according to IHS, the investor's IRR in Tanzania is only at 14%, which is lower than 20%. Thus, the total taxes will only equal to income tax. P/I ratio of 1.03 and IRR of 14% is the lowest among the frontier countries in the world. Under this fiscal regime, contractors are expected to pay a signature bonus of USD 2.5 million upon the contract signing. Other than that, there is also withholding tax of 10% after-tax cash flow payable by the contractors. Overall, the fiscal terms in Tanzania is the toughest among others. In order to attract more foreign investment into the countries, Tanzania has to review its fiscal terms so that it will look favorable to investors to go and do the investment in their upstream sector.

- Local Content

There are five key areas in Tanzania's local content. The first one is the technology transfer. The purpose of this requirement is to make sure that the local companies will be able to compete with other oil and gas companies outside Tanzania. Investors are expected to hire local employees and give full access to local firms for procurement opportunities. The second requirement is to ensure the local participation in the oil and gas project. Contractors are required to provide field trainings to the local employees and to involve them in the project they are working on. The operators are also expected to give preference to the locals that have enough skills to work in the field as their employees. The next requirement is for the operators/investors to prefer the local firms in order to buy goods and services. This is to make sure that there will be opportunities for the local firms to increase its value addition together with the increase in the jo opportunities. Other than that, investors must give preference to the local firms for fabrication and manufacturing processes. It is to train the local firms on how to meet the industry demand. The last requirement is for the operators to imply socio-economic responsibilities in the countries. Contractors are required to submit CSR plan for the government of Tanzania to approve first. Operators are expected to also taking female employees into their companies.

III. Accessibility

Number of open blocks	Number of farm-in opportunities	Bid round availability
24	9	Onshore Bid Round - Unconfirmed

- Infrastructures

Technically, there are no oil infrastructures in Tanzania. They used to have a refinery plant in Dar-es-Salaam but it was closed in 1999 since it was not economic. However, the plant is still acting as a storage facility. Other than that, they also have a pipeline network with a capacity of 12,000 b/d. The length of the pipeline is 1710 km, used for transporting crude oil from Tanzania to Zambia. As for gas facilities, there are two Gas-to-Electricity projects in Tanzania. One is in Mnazi Bay which already starts its operation back in 2007 and Songo-Songo project, started in 2004. The Mnazi Bay project has 10 mmcfd gas processing facility, a 27 km pipeline network and a power station that is expected to be expanded to 18 MW by the end of 2017. As for Songo-Songo project, it has 105 mmcfd gas processing plant, a 322 km of pipeline network, 6 gas turbines for power generation, 16 km pipeline to a cement plant in Wazo Hill and 50km of low distribution pipeline. In order to meet the domestic gas demand, Tanzania is expected to increase the Songo-Songo plant capacity to 140 mmcfd (Figure 70 and Figure 71).

Pipeline	Operator	From	To	Length (km)	Diameter (inches)	Capacity (mmcfd)
Songo Songo-Somanga Funga	Songas	Songo Songo	Somanga Funga	25	12	105
Somanga Funga-Dar-es-Salaam	Songas	Somanga Funga	Dar-es-Salaam	207	16	105
Dar-es-Salaam-Wazo Hill	Songas	Dar-es-Salaam	Wazo Hill	16	8	
Mnazi Bay-Mtwara Power Plant	Wentworth Resources	Mnazi Bay	Mtwara Power Plant	27	8	65

Figure 70: Pipeline networks in Tanzania

Pipeline	Planned Start-up Year	Sponsor	From	To	Length (km)	Diameter (inches)	Capacity (mmcfd)
Mnazi Bay - Somanga Funga	2014	Songas	Mnazi Bay	Somanga Funga	275	36	220
Songo Songo - Somanga Funga 2	2014	Songas	Songo Songo	Somanga Funga	35	24	105
Kiliwani North - Songo Songo	2014	Songas	Kiliwani North	Songo Songo	3	6	20
Block 1- LNG plant	2022	BG	Jodari	Tanzania LNG Plant	148		
Block 2 - LNG plant	2022	Statoil	Zafarani	Tanzania LNG Plant	85		
Block 4 - LNG plant	2024	BG	Chewa	Tanzania LNG Plant	255		

Figure 74: Future plan on gas infrastructures in Tanzania

- Number of open and farm-in opportunities blocks

There are 9 farm-in opportunities blocks currently in Tanzania. Form the 9 blocks, 5 of them are in the Ruvuma basin, 2 of them are in Rufiji Depression Basin, one of them is in Pemba-Zanzibar and one in the Ruhuhu Graben basin. All of the blocks are in the surface exploration/drilling stage except for block Songo Songo field which is in the development stage. 8 of the blocks are located onshore and only 2 of them are deep-water region. As for the open blocks, there are 24 blocks available for bidding process. Half of the blocks are in deep-water and half of them are in either land or shallow water region. Most of the blocks are located in the Somali Deep Sea Basin or Mafia Deep Sub-Basin. The total number of the blocks are quite high in Tanzania as compared to other countries. But in order to fully develop them, they have to make sure that their fiscal regime is attractive enough for the investors to start investing in the country. The most prolific basin for deep-water exploration is Tanzania Coastal basin. Another two main basin in Tanzania are Rovuma basin and Rift basin. The prospect in other basins remain to be seen. Further exploration activities are required to confirm the success rate in those basins.

- Bid Round

Upon the approval of the new gas law, Tanzania has held a licensing round in 2013. 8 blocks were offered in that licensing round which are 4/2A, 4/3A, 4/3B, 4/4A, 4/4B, 4/5A, 4/5B, and Lake Tanganyika North. Bid was closed in May 2015 with companies like CNOOC, Statoil, ExxonMobil, Mubadala Petroleum, Gazprom, and RAKGAS have joint the bidding process. There is also an Onshore Bid Round that is

still unconfirmed by the Tanzania Petroleum Development Corporation. It is said that around 7 blocks in the Lake Eyasi-Wembere-Natron-Manyara area will be offered for foreign investment.

IV. Country Risk

Sub-components	Rating	Description
Political	3.4	• Tanzania's politic is quite stable when it is compared to other African countries. • The political environment has changed from one-party state to a multi-party. • The popularity of the ruling party, Revolutionary Party of Tanzania has decreased in the last election due to people have lost their faith in the party – because of the corruption issues. • In order to reduce the tensions between the supporters, CCM and the opposition Civic United Front (CUF), have decided to form a unity party. • However, the riots are still continue because it is believed the members of the separatist Islamist group Uamsho (Awakening) have choose to give their supports to a more radical party than CUF.
Economic	2.0	• Tanzania achieved their independence in 1960s and since then, their economy has develop strongly especially after they have decided to abandon the African socialism and a planned economic system. • Helped by the foreign aids for the past 15 years, Tanzania was able to develop its mining, tourisms and agriculture sectors successfully. • However, the agriculture sector in Tanzania is largely affected by the fluctuate weather in Africa region. • As for the oil and gas sector, the huge discoveries have helped Tanzania to attract foreign investment. But, due to the rapid decline in oil prices, the projects planned for the development of natural gas are in doubt.
Security	2.5	• Tanzania can be said as a stable country in terms of security. It is achieved through the relationship with it neighbor countries. • The main security problem in Tanzania is crime issues. It is concentrated in the urban areas. • In the coastal area, there is also a problem with the radical Islam. Other than that, there is also political unrest in the Zanzibar Island. • An agreement signed by both political parties have somehow fails to stop the political unrest in the Zanzibar Island.

4.2 Result & Discussion

Table 31: Final ranking

Country	Resource Potential			Fiscal Terms			Accessibility		Country Risk			
	Reserve (22.5%)	Prob. of discovery (22.5%)	Tax distortion (6.8%)	Gov. take (3.4%)	Local Content (3.4%)	Infrastructure (11.6%)	No. of blocks (8.7%)	Bid Round (8.7%)	Politic (3.6%)	Economic (3.6%)	Security (1.8%)	Overall (100%)
Mexico	5.00	3.00	3.00	2.00	4.00	5.00	2.00	5.00	2.80	4.10	2.60	**3.09**
Myanmar	4.00	2.00	4.00	2.75	2.50	5.00	3.00	3.00	2.50	2.70	2.40	**2.78**
Cote d'Ivoire	2.00	3.00	3.50	3.50	4.00	4.50	4.00	5.00	2.90	2.80	2.50	**2.62**
Kenya	3.00	3.00	3.50	4.50	4.00	3.50	3.00	3.00	2.30	2.50	2.90	**2.51**
Gabon	5.00	4.00	2.75	2.00	1.00	4.00	5.00	1.00	2.20	2.20	1.80	**2.66**
Angola	4.00	4.00	2.50	2.00	3.00	3.50	4.00	3.00	2.20	2.30	2.00	**2.52**
Tanzania	4.00	4.00	1.50	2.50	2.00	2.00	4.00	3.00	3.40	2.00	2.50	**2.25**
Mozambique	4.00	4.00	5.00	3.00	2.00	3.00	1.00	1.00	2.90	3.30	2.90	**2.31**

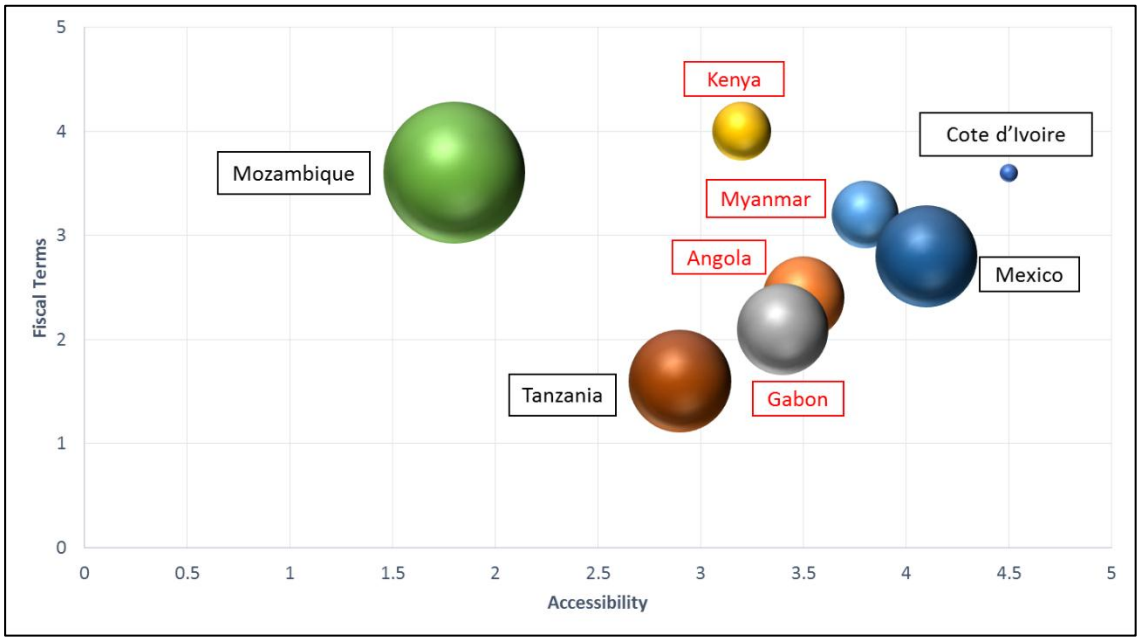

Figure 72: Final analysis

From the final result table above, it can be concluded that Mexico is the most exciting hotspot for the upstream investment. The strength of Mexico lies in its resource potential where it has around 4 Bboe of oil and 0.25 probability of discovery. Although its local content is no so strict, its government take of 84% is high enough for the investors. As for the risks, it is quite stable economically but has some drug activities in the southern part of the country.

Myanmar is in the second place. Although it has a vast amount of gas resources, its probability of discovery has been low. Its fiscal regime has been in the average zone due to high government take and strict local content but availability of infrastructures to develop the gas field has improved its overall rating.

Gabon is in the place with a score of 2.66. It has vast amount of yet to find reserves, 3.2 Bboe of oil. Its probability of discovery is also high which is around 0.45. But due to the tough fiscal terms in its country, 90% local content, 85% of government take and a low 0.67 tax distortion has lowered is final ranking. Angola's case is almost the same as in Gabon except it has a better local content but a lower total yet to find oil. In terms of country risk, both of the countries are in the same level.

Cote d'Ivoire is in the fourth place. It has the lowest amount of reserves as compared to other countries in this study which is around 0.12 Bboe of oil but due to its low fiscal terms of 64% and high tax distortion together with the high accessibility has improved its final ranking significantly.

As for the countries in the East Africa region, the attractiveness has been low due to the tough fiscal terms and lack of infrastructures to fully develop their resources except for Kenya who has a good fiscal terms. In terms of yet to find reserves, Mozambique and Tanzania has a huge amount of gas reserves. But a tough fiscal term and lack of infrastructure will hindered the development in the countries themselves.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

It is important for oil and gas industry to look for new exploration in order to move away from traditional resource/production centre. Fail to do so, it might be bad for the market in long term as it can create an unstabilize market like what is happening now, the sudden drop of oil prices from 120 $/bbl to 50 $/bbl as of 5 February 2015 (Bloomberg, 2014). Other than that, countries in Africa are ready to open up their oil and gas industry to be developed in order to boost their economy. Sub-Saharan Africa represents almost 30% of total oil and gas discoveries for the past 5 years (African Energy Outlook, 2014). It should be attractive enough for the investors to start entering those countries and exploit their oil and gas potential. It is also important to know that these new exploration areas could help to arrest the decline of production from mature fields around the world.

This study has been proposed in order to look for the best hotspots and also to find the best country for the investment to be made. This study has highlighted four main components which are resources, fiscal terms, accessibility and country risk. Each component has been given the weightage for the calculation to be made. Resources and accessibility represent 74% of the weightage applied while another 26% has been divided between fiscal terms (17%) and country risk (9%). This project will be further analysed by assessing each on the components in details. All the data for each components will be collected and compared between the eight selected countries. After being rated and being given the weightage, these countries will finally be ranked in order to find the hotspot with the biggest potential for the upstream investment to be made.

From the results, it can be concluded that Mexico is the best hotspot for the upstream investment. A vast amount of resources and great accessibility have helped Mexico to be ranked in the first place. As for Myanmar, after sanction has been lifted in 2011, the E&P activities have increased significantly. However, the countries in the Africa region need to improve in terms of providing good infrastructures for the development of oil and gas resources and revise their fiscal regime so that it will become more attractive in the eyes of the investors. It is vital for them especially for Tanzania and Mozambique since they have a vast amount of oil and gas resources to be developed. Country risk is still a problem for most of the hotspots especially in the African region. There are a lot of pirate activities, political problems and civil war unrest. Mexico and Myanmar have drugs issue and religion tension respectively in their country. Although the weightage for country risk is low, it is important for all of the countries to try and solve all these problems so that the working environment will be much safer in their countries.

As for the recommendation, it is recommended that the number of basin studied to be increased so that a clear picture on the probability of discovery could be calculated. Under this study, only one basin, the most prolific basin, has been chosen to calculate the probability of discovery. With more than one basins being studied, the average probability of discovery of a certain country could be calculated. Other than that, it is also recommended that the number of hotspot to be increased also so that the investors will have more choices to be chosen from.

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APPENDICES

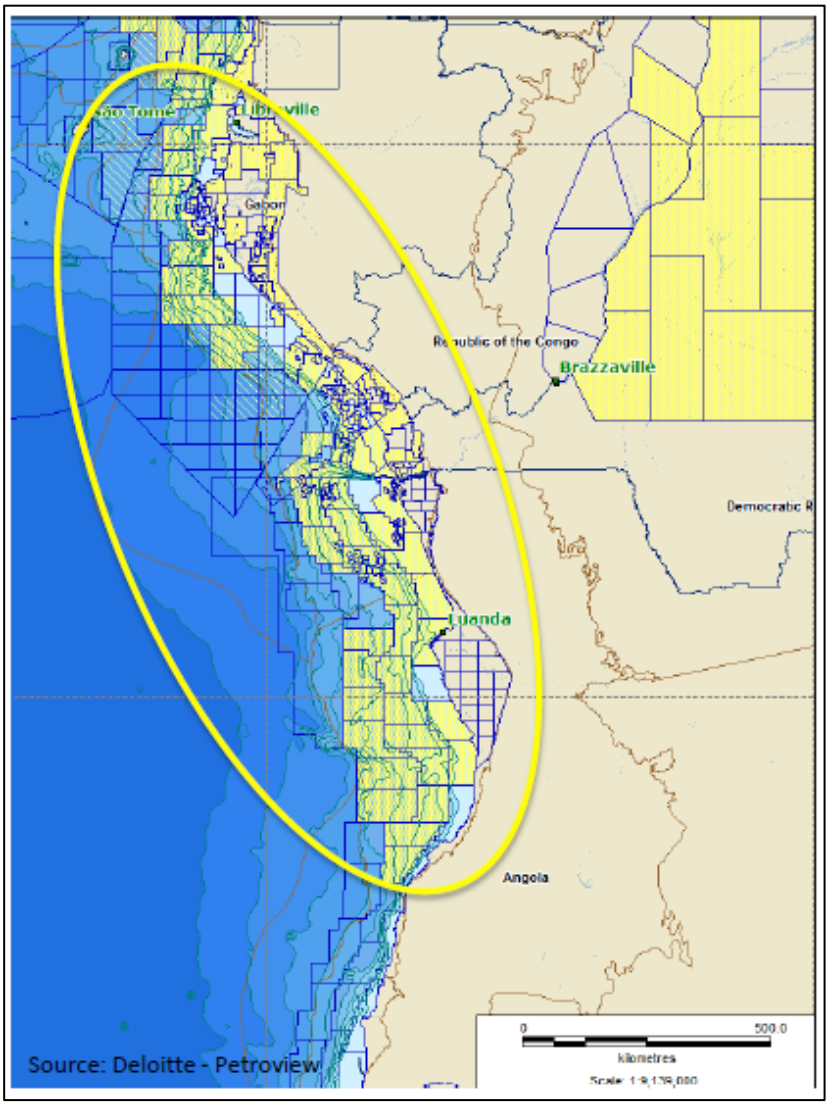

Figure 73: Angola and Gabon pre-Salt Map

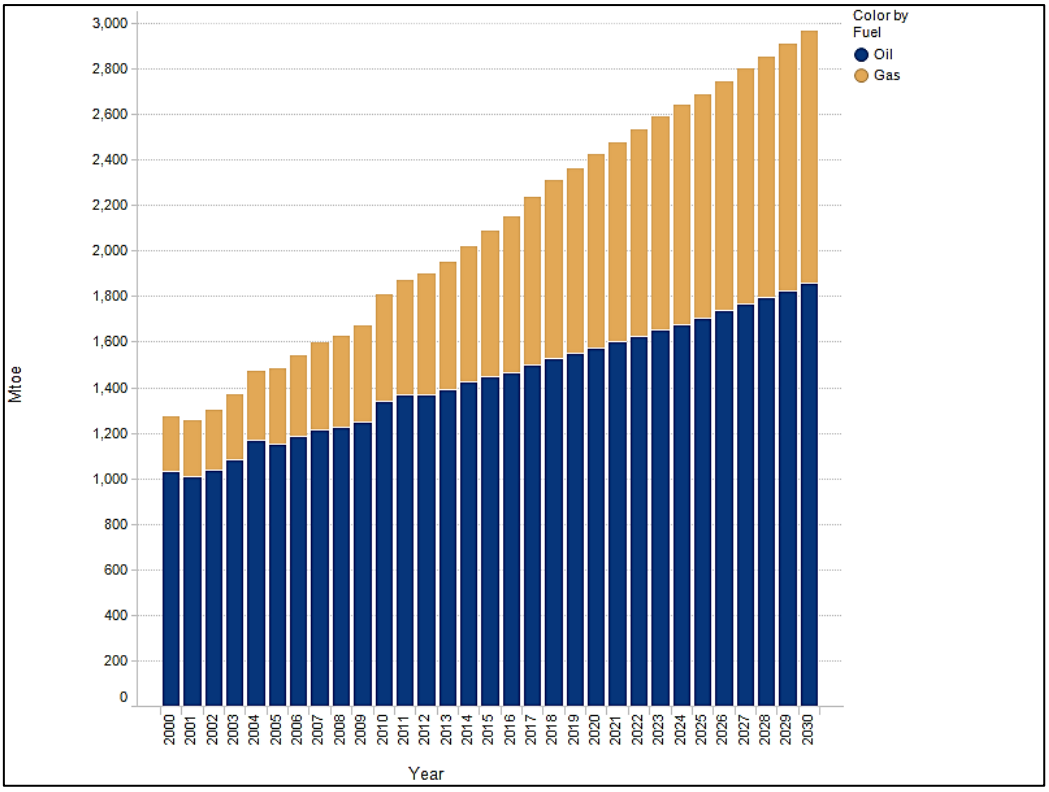

Figure 74: Oil and gas demand