Energy Basket of India 2035 – E&P Perspective
Identifying Focus Areas Overseas for Acreage Acquisitions

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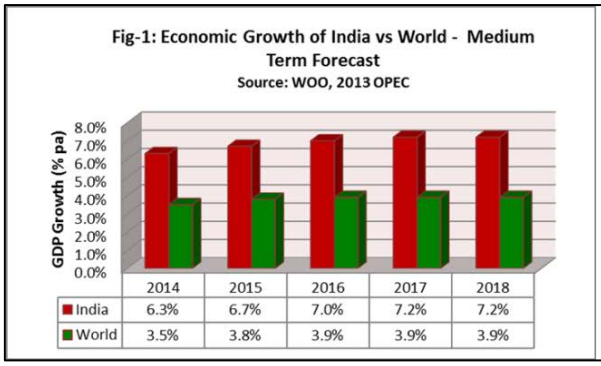
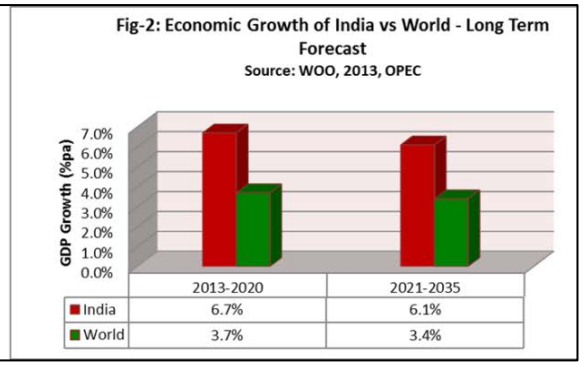
Abstract
Hydrocarbons will remain the dominant energy type to provide energy security to the world for next 25 years. India's demand of crude oil in 2035 is projected at 9.0 MMbopd from current demand of 3.7 MMbopd, approximately 140% increase. To fulfill the growing demand of India's primary energy requirement and reduce hydrocarbon deficit, acquiring stake in exploration/development/producing acreages overseas is one of the way forward besides enhancing domestic reserve base and improving recovery factor of existing fields.
Attractiveness of upstream petroleum acreages is influenced by various factors e.g. geology of the basin, acreage location, cost factors, fiscal regime and risk profile of the host country. Assuming other factors remaining the same, geological prospectivity and the fiscal regime of the country are the two most important factors influencing the attractiveness of the acreage for acquisition.
Present work is an attempt to assess attractiveness of the countries based on the hydrocarbon prospectivity in terms of undiscovered resources and attractiveness of fiscal regime in terms of government take. Countries/basins worldwide particularly along the east and north western coast of Africa, North Eastern coast of South America, Far East countries neighboring India and few countries of Australasia region have been analyzed for hydrocarbon prospectivity and 'Undiscovered Resource potential'. Economic analysis for these countries has been attempted to calculate 'Government Take' on assumed field sizes after incorporating fiscal terms. These countries were further analyzed for current proved reserves, oil production and export status. The gap between current proved reserves and estimated Undiscovered Resources can be attributed to poor/moderate exploration effort. Further exploration effort in these countries require huge investment and hence opens up an opportunity for Indian companies to seek investment opportunity in E&P ventures with an objective of achieving energy security for India. An attempt has been made to rank these shortlisted countries for investment attractiveness.
The analysis and methodology may help Indian Government/Indian companies to focus and shortlist the region/countries for investment attractiveness and acquisition of E&P acreages.

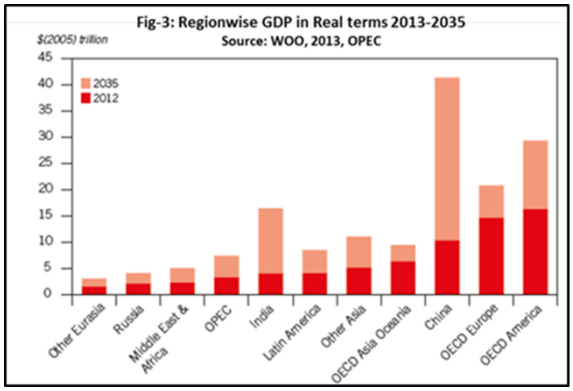
Key words: Fiscal Regime, undiscovered resources (UR), government take (GT).

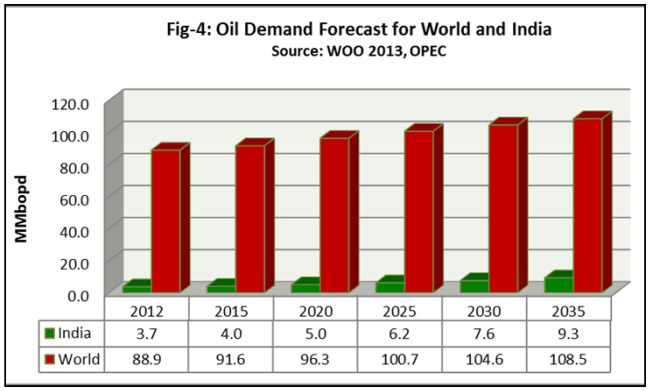
Introduction: Few Facts & Forecasts
Economic Growth: The Euro zone crisis had forced a major downward revision of the assumed growth rates globally in 2011-12. Positive developments with some acceleration in growth in US and Japan despite slow recovery from recession in Europe, indicates improvement in global economic situation compared to 2012 estimates. Forecast for economic growth rate of India for the medium-term 2014-2018 is estimated at 6.3% in 2014 to 7.2% in 2017 as compared to 3.5% & 3.9% respectively for world[1]. For long term (2013-2035) average estimates for the world is 3.5% pa as compared to 6.5% pa for India, Figure-1 & 2. India which in 2010 accounted for 5.4% of the global GDP, expected to rise to 10.6% by 2035 with a real GDP of more than 10 trillion $ (Figure-3).

Energy Demand*:* Hydrocarbons will remain the dominant energy type to provide energy security to the world for next 20-25 years. Oil will be having the maximum of the share for most of the forecast period. Demand of oil for the world show an increase of 23.4% from 2010 to 2035 at a growth rate of 0.8% pa. Growth rate of demand of gas for the world is much more than oil i.e. 2.4% pa. On domestic front, demand of oil in India is expected to rise from 3.7 MMbopd in 2012 to 5.0 MMbopd in 2020 i.e. by 35.1% for the medium term and 9.3 MMbopd in 2035, an increase of approximately 150% for long term, Figure-4. Growth in oil demand is mainly from transportation sector.









Supply Side:

Oil Production: Entire Middle East is currently having largest share (32.81%/28270 Mbopd) of production of oil in the world followed by Europe & Eurasia (19.98%/17211 Mbopd) and North America (18.06%/15557 Mbopd). Asia pacific region is having 9.65% (8313 Mbopd) contribution[2]. India is having 1% share in the world's daily production with a contribution of 894 Mbopd a deficit of 2806 Mbopd in 2012.

Gas Production: Total Europe and Eurasia region is the maximum producer of gas with 30.78% share (1035.4 Bcm) in world's gas production[2] followed by North America with 26.65% share (896.4 Bcm). India's share in the total world's gas production is 40.2 Bcm (2012) which is 1.2% of the total.

Proved Reserves:

Oil: Total proved reserves[2] for entire world by the end of 2012 were estimated to the tune of 1668.9 Bbbl. Middle East regions with 48.4% of world's proved oil reserves (807.7 Bbbl) stands at top followed by South & Central America in the second place with 328.4 Bbbl (19.7%). India holds around 5.7 Bbbl of proved reserves amounting to 0.3% of the world's total proven reserves.

Gas: Total proved gas reserves[2] for entire world in 2012 were estimated to the tune of 6614Tcf (1873 Tcm). Middle East is having the maximum of the proven gas reserves with 42.98% (2842.9 Tcf) share followed by Europe & Eurasia with 31.18% contribution. India holds around 47 Tcf (1.3 Tcm) of proved gas reserves which is 0.71% of the world's total proven gas reserves. Though reserves/supply of gas doesn't look to be an issue, but most of the reserves are in regions (e.g. Middle east, Russia, North America) which are geopolitically &/or logistically not easily accessible to India.

Import Scenario: Total import of crude oil by India in the year 2012 was 177.1 MMt (3547 Mbopd)[2] which is 9.19% of the total import of crude oil worldwide. Import of gas by India in the same year was 13669 MMscm which is 1.27% of the total imported quantities by different countries of the world.

Objectives, Methodology and Assumptions of Current Study

Objectives:

In order to fulfill the growing need of the primary energy requirement & to reduce the oil trade deficit, India will need a 3% growth rate in hydrocarbon availability[3]. Acquisition of stake in producing/developing fields along with acquisition of exploration acreages overseas is one of the ways forward to reduce the hydrocarbon deficit besides enhancing the domestic reserve base and improving recovery factor of the existing fields.

For acquiring stake in overseas exploration/development acreages out of the opportunities available, one has to prioritize and rank the opportunities. Present work is an attempt to prioritize the countries for investment opportunities based on the undiscovered resource potential assessed and government take which country's fiscal system offers. Undiscovered resource assessment is an important criterion for prioritization as it is the driving force for any E&P company to explore, develop & produce. Government Take becomes important as it gives an idea whether the endeavour will make any business sense or not for the company**.**

Methodology:

i. Various regions/basins/countries of the world particularly in the neighborhood of India, western and eastern coast of Africa, north eastern part of South America and Australasia region were analyzed based on the USGS world petroleum assessment reports and other public domain data for the hydrocarbon prospectivity and undiscovered hydrocarbon resource potential.
ii. These countries were further analyzed through US Energy Information Administration data for current proved reserves, oil production & oil export status.
iii. The gap between current proved reserves and undiscovered resource estimated by USGS can be attributed to poor/moderate exploration effort in those regions/countries. Further exploration effort may require huge investment for the host countries and hence create an opportunity for other countries for investment and energy security.
iv. Economic analysis on few assumed field sizes is carried out for these selected countries to derive the Government take in each of them.
v. Countries are then ranked from investment attractiveness point of view based on the undiscovered resource potential and impact of fiscal regime followed by host government in terms of Government Take. IHS Energy database of cost and fiscal terms is used for analysis.

Assumptions: Following assumptions were considered for the analysis

i. Study is carried out assuming oil or gas as main production stream depending upon Hydrocarbon prospectivity envisaged for the country/basin.
ii. For each country, case study is attempted either for shallow offshore areas or onshore areas only. Deepwater cases are not attempted in this study. Case study is attempted for one or two reserve sizes. Lifecycle cost for each case is estimated including seismic API cost of US$15MM and one exploratory well commitment.
iii. Fiscal terms of respective country are considered for economic analysis.
iv. Oil price considered for analysis is US$ 100/bbl. Gas price considered is US$ 5/Mcf.
v. Gas to Boe conversion considered is 6Mcf = 1bbl.
vi. For countries where assessment of undiscovered resources is combined total resources are divided equally among countries for comparison sake.
vii. Economic analysis is worked out to estimate Government/Company take from the project. Average Government/Company take estimated from two cases is taken for comparison.

Hydrocarbon Prospectivity & Undiscovered Resource Potential

Assessment carried out by USGS in 2012 (or earlier) has been considered as basis to understand and assess hydrocarbon prospectivity and Undiscovered Technically Recoverable Reserves base of the regions/countries shortlisted in this work. These shortlisted 23 countries spread over 6 regions of the world are East Africa (Four countries Madagascar, Mozambique, Seychelles and Tanzania), West Africa coastal region (Three countries Guinea, Liberia and Sierra Leone), North West Africa (Five countries Senegal, Guinea Bissau, Gambia, Mauritania and Morocco), North Central Africa (Two countries Chad and Niger), Guianas Equatorial margin South America (Two countries Guyana and Suriname), South East Asia (Four countries neighboring India - Bangladesh, Myanmar, Sri Lanka and Afghanistan) and Australasia region (Three countries Australia, New Zealand and Papua New Guinea). Summary of the USGS assessment in these regions and countries in terms of basin in which these resources are assessed, Total petroleum system (TPS)/Assessment unit (AU) defined, Total undiscovered resource potential for oil & gas and expected largest mean field size is given in Table-1.

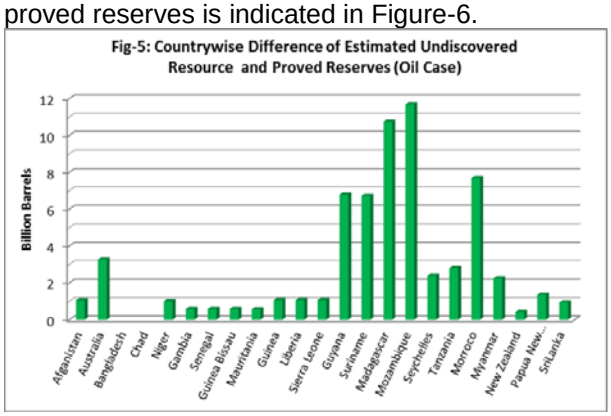
Proved Reserves Status

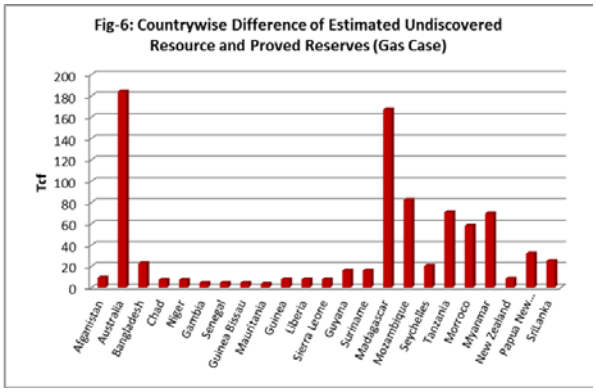
The shortlisted countries were analyzed in terms of proved reserves as per the data available in International Energy statistics, EIA. Production/consumption status of these countries was also studied. The compilation of data for the analysis for the year 2014, 2013 & 2012 is shown in Table-1.

Oil Scenario: Analysis indicates that most of the selected countries have nil proved reserves. Only two countries i.e. Australia and Chad has more than 1 Bbl proved reserves. Rest of the countries has

proved reserves less than 185 MMb. The difference between undiscovered resources estimated and current proved reserves is indicated in Figure-5.

Gas Scenario: Analysis indicates proved reserves in eleven countries are nil. For one country i.e. Suriname data is not available. Mozambique and Australia have very significant proved reserves of 100 Tcf and 43.03 Tcf respectively. Myanmar, Bangladesh and Papua New Guinea rank next with proved gas reserves to the tune of 10 Tcf, 9.344 Tcf and 5.483 Tcf. Rest six countries have proved reserves less than 1.75 Tcf. The difference between undiscovered resources estimated and current proved reserves is indicated in Figure-6.



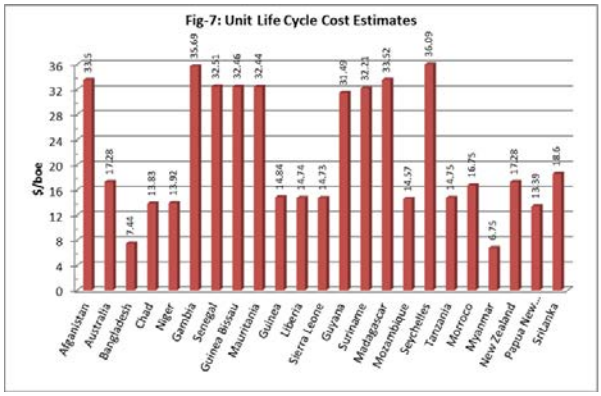


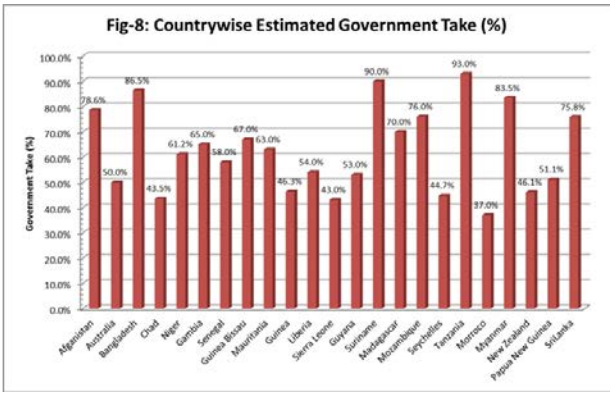
Upstream Fiscal Regimes of selected countries

Table-2 provides an overview of the upstream fiscal system/terms of the selected countries considered for Economic analysis and estimating the 'Government take'. The value of the terms mentioned in the table is indicative and represent a gross range. As many of these terms are biddable, hence their value may vary depending upon the bidding scenario and the prospectivity of the block/area/basin within that country.

Results and Discussions

The total Undiscovered Technically Recoverable Resources in 23 countries analyzed in this work covering seven regions of the world and about 26 basins are 236.31 Billion boe (67.83 Billion Barrel of Oil and 1011 Tcf of gas). In comparison, total proved reserves in these countries are 32.19 Billion boe (3.53 Billion Barrel of oil and 172 Tcf of gas) Table-1. Analysis indicates that most of the identified countries have very small proved reserves any many of them having nil proved reserves. A huge gap exists between proved reserves and undiscovered resources in almost all the 23 countries shortlisted, Figure-5 & 6. Prominent countries where gap is more than 2 Billion barrel of oil and more than 20 Tcf of gas are Mozambique, Madagascar, Seychelles and Tanzania East Africa, Guyana and Suriname of Guianas Equatorial margin in South America, Morroco of North West Africa, Myanmar and Sri Lanka in South East Asia and Australia.



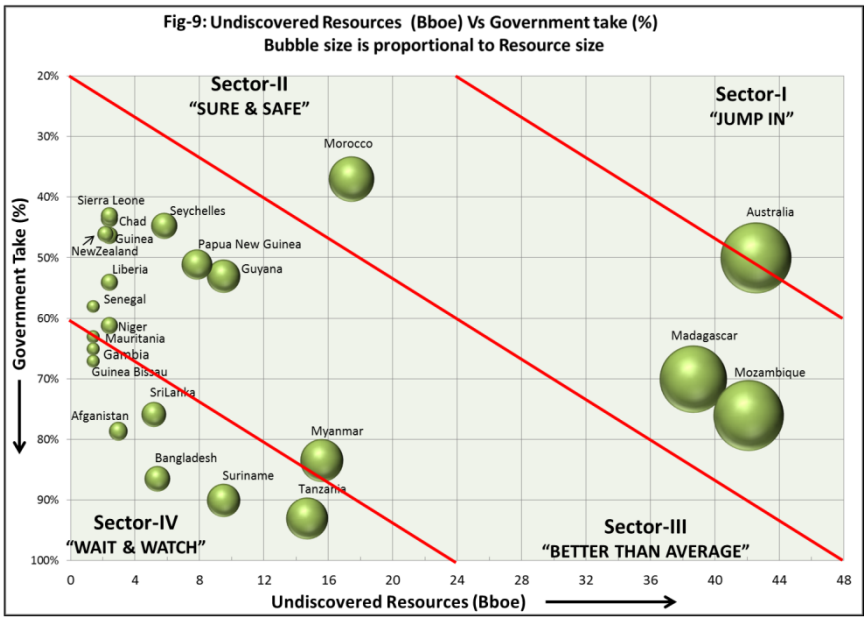


Estimated unit life cycle cost in terms of $/boe for the field sizes analyzed in each of these countries is shown in Figure-7. Maximum unit cost of 36 $/boe is estimated in case of Seychelles and minimum of 6.75 $/boe in case of Myanmar. Mean value of unit cost for the distribution is 21.69 $/boe. The higher value of unit cost for some countries is due to high cost environment e.g. high water depth. In case of Myanmar and Bangladesh low unit cost are due to the higher reserve size considered for analysis.

Out of 23 countries analyzed, 14 countries have PSC fiscal regimes whereas rest 9 countries have royalty tax regimes. In PSC regimes almost all the countries have royalty components with values ranging from 6.25-20% for oil and 5-15% for gas. The royalty rates are flat in some countries whereas it is tied to the production rates in others. Profit sharing mechanism is tied either to R-factor or to the average daily production. Cost recovery ceilings in these 14 countries vary from 50-100%. In 9 countries where royalty tax regime exists, royalty rates vary from 4% in Papua New Guinea to 12.5% in Chad and Gambia. Tax rates in these counties vary from 30%-50%. Summary of fiscal terms is given in Table-2.

Countrywise estimated government take in percentage terms after incorporating assumed fiscal terms are shown in Figure-8. Analysis indicates that Tanzania has the maximum Government Take of 93% followed by Suriname. Morocco has the minimum Government Take of 37%. Out of 23 countries analysed 8 countries have more than 70% Government Take.

To rank the countries for investment opportunities, a matrix is created by plotting Total Undiscovered Resources against the estimated Government Take as given in Figure-9. Size of the bubble is proportional to the estimated Undiscovered Resources.



Conclusions

Any opportunity in countries positioned at Sector-I of the matrix (e.g. Australia in the present work) can be defined as top rank opportunity - a "JUMP IN" case for investment. Opportunities in countries positioned in Sector-II can be defined as "SURE & SAFE" opportunities - very attractive destination for investment. In the current work Morocco, Madagascar and Mozambique qualify under this category as second rank. Opportunities in countries falling in Sector–III can be defined as "BETTER THAN AVERAGE BETS" opportunities making them reasonably good destinations for investment particularly in countries positioned in low Government take area. These opportunities are ranked number three. In the current work, 12 countries are falling in this category i.e. Myanmar, Guyana, Papua New Guinea, Seychelles, Sierra Leone, Chad, New Zealand, Guinea, Liberia, Senegal, Niger and Mauritania. Sector-IV can be defined as 'WAIT & WATCH" case for now and countries positioned in this sector are ranked fourth. Gambia, Guinea Bissau Sri Lanka, Afganistan, Bangladesh, Suriname & Tanzania are the countries shortlisted in current analysis fall in this category. These priorities may change with change in fiscal regime or a new big discovery.

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Table-1: SUMMARY OF ESTIMATED UNDISCOVERED RESOURCES (Source: USGS World Petroleum Resource Project) AND PROVED RESERVES (Source: International Energy Statistics, EIA)						
REGION	**COUNTRY**	**BASIN - TPS - ASSESSMENT UNIT**	**UNDISCOVERED RESOURCES (MEAN)**		**PROVED RESERVES**	
			OIL (MMb)	**GAS (Bcf)**	**OIL (MMb)**	**GAS (Bcf)**
East African Region	Madagascar	Morondava-Mesozoic Composite TPS	10750	167219	0	71
	Mozambique	Coastal-Mesozoic Composite TPS	11682	182349	0	100000
	Seychelles	Mesozoic-Cenozoic Composite TPS	2394	20376	0	0
	Tanzania	Coastal-Meso-Cenozoic Composite TPS	2806	71107	0	230
West Africa	Guinea	West African Coastal-Cretaceous Composite TPS	3200	23629	0	0
	Liberia					
	Sierra Leone					
North West Africa	Senegal	Senegal province-Cretaceous Tertiary Composite TPS	2350	18706	0.02	1000
	Guinea Bissau					
	Gambia					
	Mauritania					
North West Africa,	Morroco	Essaouira Basin Province Essaouira Basin AU	128	902	-	-
		Essaouira Basin Province Offshore salt structures AU	7557	57406	-	-
	Total		**7685**	**58308**	**0.68**	**51**
North Central Africa	Chad	Chad Basin Province Tertiary Composite TPS	2315	14648	1650	0
	Niger					
Guianas Equatorial Margin, South America	Guyana	Guyana Suriname Basin Province	13608	32032	76.7	0
	Suriname					
South East Asia	Myanmar	Central Burma Basin Eo-Miocene TPS	1808	12672	-	-
		Irrawady-Andaman AU	397	35928	-	-
		Cenozoic AU	95	31010	-	-
		Total	**2300**	**79610**	**50**	**10000**
South East Asia	Afganistan	Amu Darya Basin Meso- Cenozoic TPS Karabil-Badkhyz AU	112	4163	-	-
		Afgan-Tazik Basin Meso-Cenozoic TPS Western AU	44	5605	-	-
		Afgan-Tazik Basin Meso-Cenozoic TPS Eastern AU	902	1427	-	-
		Total	**1058**	**11195**	**0**	**1750**
South East Asia	Sri Lanka	Mesozoic-Cenozoic TPS Northern Cauvery Basin AU	458	12979	-	-
		Mesozoic-Cenozoic TPS Mannar Basin AU	483	12229	-	-
		Total	**941**	**25208**	**0**	**0**
South East Asia	Bangladesh	East Folded Belt, Faulted Anticlines	-	21130	-	-
		North Eastern Surma Basin	-	8140	-	-
		Wester Platform & Slopes	-	2846	-	-
		Total	-	32116	28	9344
Australasia	Papua New Guinea	Papua new Guinea Fold belt AU	1215	26775	-	-
		Papua Platform AU	325	10875	-	-
		Total	**1540**	**37650**	**185.93**	**5483**
Australasia	New Zealand	Cretaceous Tertiary Composite TPS-Taranaki basin AU	487	9797	81.4	1039
Australasia	Australia	Bonaparte Basin, Paleo-Mesozoic TPS	930	55325	-	-
		Browse Basin, Paleo-Mesozoic TPS	633	38490	-	-
		Gippsland Basin, Cret-Tertiary TPS	137	2549	-	-
		Northern shelf, Mesozoic TPS	3001	130642	-	-
		Total	4701	227006	**1433** #	**43037** #
# Proved Reserves for whole Australia whereas Resource for defined basins						

Table – 2: Overview of Fiscal Terms considered for Economic Evaluation

PSC Regimes

Country	Royalty	Cost recovery ceiling	Profit oil/gas split	Bonuses	Income Tax	State Participation
Guinea	15%	50%	75%-50% sliding scale tied to daily Prod	NIL	35% - 7 Yr tax holiday	15% carried thru Commercial disc
Liberia	NONE	80%	50%-35% sliding scale tied to daily production	Prod-$ 0.1MM @ prod 30,50,100 Mboepd	NONE	NONE
Mozambique	Oil-10% Gas-6%	70%	95%-50% sliding scale tied to R factor	Prod $ 0.2@MM prod start & for each 25 Mboepd	32% Withholding Tax – 20%	10% carried thru Commercial discovery
Madagascar	Oil-8%-20% Gas-5%-10% sliding scale linked to prod	65%	Oil: 75%-30% tied to R factor Gas: 50%	Sig: $0.5MM Prod-$1MM @ 25, 50, 100 Mboepd	35%	NONE
Mauritania	NONE	70%	80%-50% sliding scale tied to avg daily prod	Sig Bonus: $100,000 Prod: $2-3MM	40%	10% carried thru discovery
Niger	Oil:15%, Gas:5%	70%	40% Flat rate	Sig: $1 MM	NONE	20% carried thru discovery
Senegal	NONE	50%	65%-45% sliding scale tied to R factor	NONE	35% Paid by State	10% carried throughout. Addl 10% carried thru discovery
Tanzania	12.5%	50%	Oil:30%-10% Gas:40%-15% sliding scale tied to daily prod & State Participation	NONE	30%	25% carried thru discovery
Guyana	NONE	75%	50%	NONE	Paid by State	NONE
Suriname	6.25%	70%	85%-15% sliding scale tied to R factor	NONE	36%	15% carried thru Exploration. No repayment
Afganistan	Minimum 8%	100%	100%-30% sliding scale tied to R factor	NONE	Either fixed-30%, or floating-20%	NONE
Bangladesh	NONE	55%	Biddable 45-20% tied to prod rates	Disc: $3MM Prod: $0.5 - $4MM tied to daily Prod	37.5% DSO: OIL-80% @ 15% discount. Gas-100% @ discount	10% carried thru comm. Discovery. Reimburse at prod start
Myanmar	12.5%	50%	Oil: 40%-10% Gas: 35%-10% sliding scale tied to avg daily Prod	Sig: $ 2MM Disc: $ 1MM Prod:$2, 3, 4, 5,& 10 MM @ 25, 50 100 150, 200 Mbopd or 150 ,300 ,600, 750 & 900 MMscfd	25% of contractor's Profit share. 3 year tax holiday DSO: Oil 20% Gas-25%	20% carried thru discovery. Reimburse at prod start.
Srilanka	10%	70%	85%-15% sliding scale tied to R factor	Sig: $ 1MM, Prod $ 50MM at prod start	12%, 8 yr tax holiday from proj start	15% carried thru discovery

Royalty Tax Regimes

	Royalty	Bonuses	Income Tax	State Participation
Australia	10%	NONE	30%	NONE
Newzealand	Greater of 5% of Gross Revenue less transport less storage and 10% of Gross Revenue less Capex and Opex	NONE	30%	NONE
Papua New Guinea	2% Stae Royalty, 2% development Royalty	NONE	Oil:45% Gas: 30% Addl 2% fiscal stability	Oil: 22.5%, Gas: 19%
Gambia (*)	12.5%	NONE	35%	30% carried thru Prod start
Guinea Bissau	5%-12% sliding scale tied to daily prod	Prod-$250,000	35%	30% carried thru Commercial disc
Morroco	Oil:10% Cumm Prod> 2.25MMb, Gas: 5% Cum Prod>10.59Bcf	Disc: $1MM Prod-$1MM @ prod 25, 50, 100 Mboepd	30%	25% carried thru discovery
Seychelles	Oil: 5%	NONE	35%	NONE
Seirra leone	Oil:10%, Gas:5%	NONE	37.5%	NONE
Chad	Oil: 12.5%, Gas: 5%	Sig: $ 0.5MM	50%	NONE