9 July 2014

Oil & Gas: Exploration & Production

Primer – 10 Things You Need To Know

PhillipCapital
Your Partner In Finance

UNITED STATES | OIL & GAS | EXPLORATION & PRODUCTION

E&P (Exploration & Production) Demystified

We observed that many retail investors are interested in the oil & gas industry, given the wide media exposure (Libya/Syria/Iraq uprisings and their impact on oil prices) and how the refined products (petrol, diesel, jet fuel etc) power our economy in multiple industries. At the same time, many are unclear about what this industry entails, or what metrics to look out for when analyzing energy stocks.

In this primer specifically focusing on upstream assets (ie. Exploration & Production), we aim to quickly summarize the important takeaways for retail investors, and in some ways serve as a crash course for readers to quickly get up to speed. The various chapters briefly covered in this report are listed below:

1. Different Types of Oil/Gas
2. Resources vs Reserves
3. Exploration Process
4. Production Rate (boe)
5. Enhanced Oil Recovery
6. Cash & Non-Cash Costs
7. 1P/Production Ratio
8. Exploration Success Rate
9. % FCF to Capital Expenditure
10. Identifying Top Picks

While we aim to cover as many producers as possible, we have deliberately omitted out oil & gas royalty trusts, as well as companies whose reserves are primarily in oil sands. In contrast to real estate, whose running cost is low after construction and can be leased out for 40 years or more with little ongoing capex, oil & gas royalty trusts are subject to increasing production cost as secondary and enhanced recovery techniques (discussed in further detail later) are employed to coax more production. Eventually, the oilfield becomes uneconomical and production declines, unless new reserves are discovered or injected into the trust.

As such, we are concerned investors might be seduced by high yields and rush into the royalty trusts, without realizing the dangers. For instance, Chesapeake Granite Wash Trust has fallen 42.77% since 2011 IPO. Its historical dividend yield of 24.67% looks enticing, but due to financial engineering that is expected to unwind as early as 2015. Quantitative methods would not have highlighted these pitfalls, and thus we decided not to include these stocks in the scope of this report.

Oil sands, while holding great promise as a crude oil substitute, is still relatively unproven and reserves ownership concentrated in the hands of a few Canadian producers. Moreover, oil sands sell for roughly 40% discount to crude oil, yet costs more to extract. Given the current limited information and comparables, we would certainly revisit the oil sands industry when more visibility surfaces.

In summary, we hope readers will find this report educational and identify a few stock picks from our shortlist that is worthy of further research and investment.

Lowest Adj. EV/1P Weighted By Price

1. BP PLC (NYSE: BP)
2. Marathon Oil (NYSE: MRO)
3. ConocoPhillips (NYSE: COP)
4. PetroChina (NYSE: PTR)
5. Hess Corp (NYSE: HES)

Highest % Reserves Mix (Natural Gas)

1. Southwestern (NYSE: SWN)
2. Cabot Oil & Gas (NYSE: COG)
3. EQT Corporation (NYSE: EQT)
4. Chesapeake Energy (NYSE: CHK)
5. Noble Energy (NYSE: NBL)

Highest % Reserves Mix (Crude Oil)

1. Marathon Oil (NYSE: MRO)
2. Murphy Oil (NYSE: MUR)
3. Occidental (NYSE: OXY)
4. Chevron Corp (NYSE: CVX)
5. BP PLC (NYSE: BP)

Highest Production Growth Rate

1. Cabot Oil & Gas (NYSE: COG)
2. EQT Corporation (NYSE: EQT)
3. Range Resources (NYSE: RRC)
4. EOG Resources (NYSE: EOG)
5. Noble Energy (NYSE: NBL)

Highest Dividend Yields

1. BP PLC (NYSE: BP)
2. Total SA (NYSE: TOT)
3. Royal Dutch Shell (NYSE: RDS-A)
4. PetroChina (NYSE: PTR)
5. ConocoPhillips (NYSE: COP)

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1. Different Types of Oil/Gas

According to US Energy Information Administration (EIA), natural gas is defined as "gaseous mixture of hydrocarbon compounds, the primary one being methane". Crude oil is defined as "mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure", and further broadly categorized into *sweet* and *sour* according to their sulphur content. Traditionally, sweet crude (< 0.5% sulphur) is favoured due to less sulphur removal.

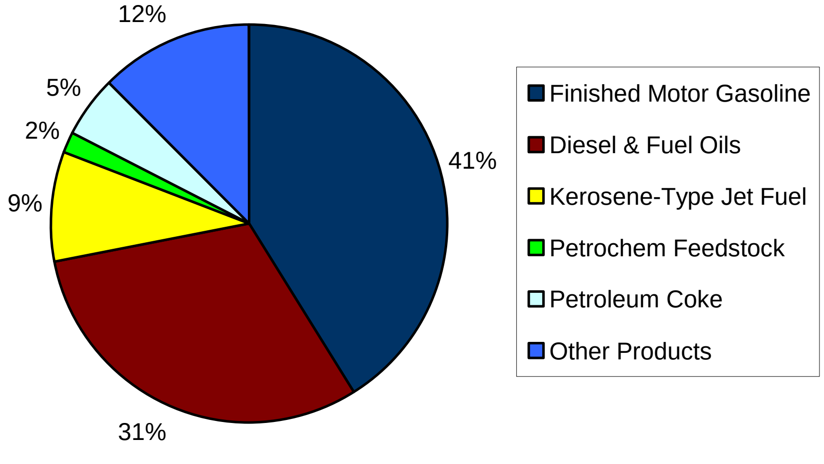
West Texas Intermediate (WTI) and Brent are two grades of crude oil used as benchmarks for oil pricing. Most of the US and Canadian interior production is pegged to WTI, whereas Europe, Africa and Middle East are benchmarked against Brent. WTI prices used to closely track Brent for decades, but began diverging substantially since 2011 and once traded at $27/bbl discount to Brent. It last closed 30 June 2014 at less than $8/bbl. This divergence arose primarily because storage and pipeline capacity have failed to keep up with tight oil production increase in the US and Canadian interiors, leading to a glut that depressed WTI prices.

Natural Gas Liquids (NGLs) lie somewhere in between, in the sense that they are non-crude oil liquids that are naturally found together with natural gas, and made up of lighter hydrocarbons (ethane and propane make up > 50% composition). Higher production (alongside shale gas) and lower energy content (than crude oil) means that NGL currently sells for ~30% the price of crude oil, barrel for barrel.

Shale Gas/Tight Oil refers to hydrocarbons produced from shale formation. Its renewed interest was due to the use of newer technologies (horizontal drilling and hydraulic fracturing) that enabled its economic extraction. By 2012, the share of shale gas vs overall US gas production has increased from zero to 1/3 in five years.

Oil Sands are essentially combination of clay, sand and bitumen (heavy, viscous oil). Due to the viscosity, they are commonly mined by excavation, instead of being pumped up a well. After mining, they are trucked to an extraction plant where hot water is added, and the resulting mix agitated for the bitumen to be removed for further processing, transportation and refining. According to US Bureau of Land Management, **it takes about two tons of Oil Sands to produce 1 bbl of oil**. As such, the process is energy-intensive and oil sands projects often have higher marginal cost of production than conventional oil production. That being said, this can also be an advantage as it translates into increased sensitivity to higher oil prices.

Although crude oil and natural gas are commonly grouped together as "Energy", their uses are anything but similar. Crude oil is mostly refined into products such as gasoline (cars), diesel (trucks), kerosene (jet fuel), and naptha (plastics). As seen in the pie-chart below, **81% of the refined products are used for transportation.**

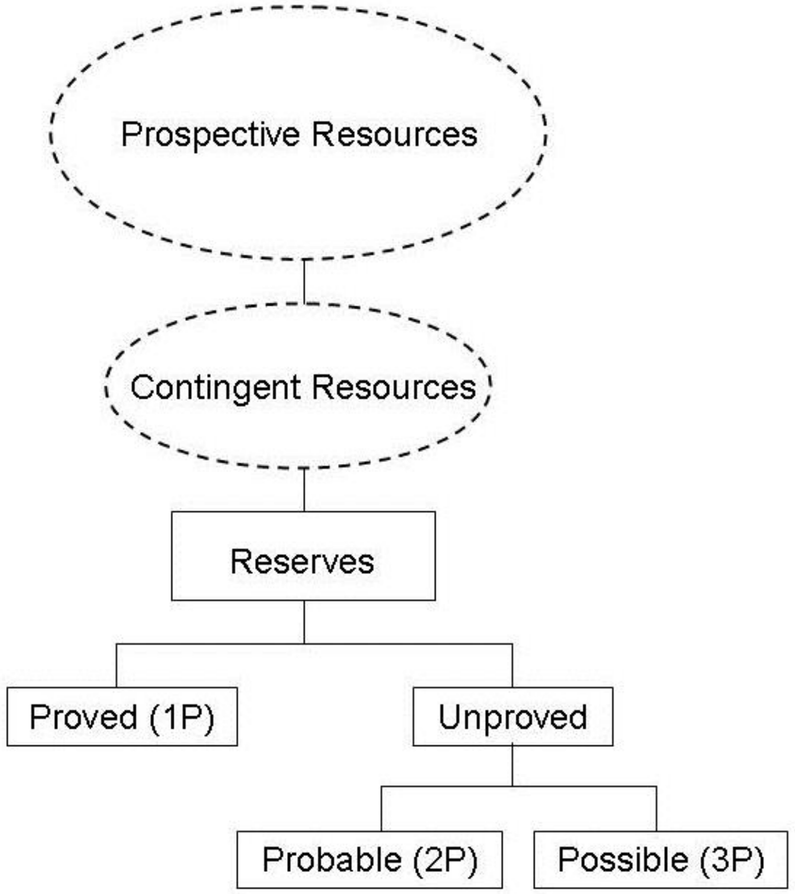


Source: EIA Refinery Yield

On the other hand, natural gas is used in power plants (electricity generation), chemical feedstock (fertilizers, plastics), and also residential heating. Indeed, in recent years its price has spiked in tandem with strong winter demand, then typically weakens towards summer when there is little to no need for heating. The pending start-up of a few LNG export plants might skew the pricing economics towards overseas demand (where natural gas currently sells for ~$14/mcf vs less than one-third in US), but it must be noted that LNG exports are costly and expected to require a premium of > 100% over today's spot price for it to be viable.

Confusingly, gasoline short-hand is also "gas", such as headline <July 4th gas prices highest since 2008 thanks to Iraq>, and not to be confused with natural gas.

2. Resources vs Reserves



<u>Definitions – Society of Petroleum Engineers and World Petroleum Council</u>
PROSPECTIVE RESOURCES – *those quantities of petroleum which are estimated, on a given date, to be* ***potentially recoverable*** *from* ***undiscovered accumulations****.*

CONTINGENT RESOURCES – *those quantities of petroleum which are estimated, on a given date, to be* ***potentially recoverable*** *from* ***known accumulations, but not currently considered to be commercially recoverable*** (due to constraints).

RESERVES – *those quantities of petroleum which are anticipated to be* ***commercially recovered*** *from* ***known accumulations*** *from a given date forward. The uncertainty* ***depends chiefly*** *on amount of* ***reliable geologic and engineering data available*** *at the time of the estimate and the* ***interpretation of these data****.*

PROVED RESERVES (1P) – *those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with* ***reasonable certainty*** *to be* ***commercially recoverable****, from a given date forward, from* ***known reservoirs*** *and under* ***current economic conditions, operating methods, and government regulations****.* ***≥90% probability*** *quantities actually recovered equal/exceed estimates.*

PROBABLE RESERVES (2P) – *those unproved reserves which analysis of geological and engineering data suggests are* ***more likely than not to be recoverable****. At least* ***50% probability*** *that quantities actually recovered will equal or exceed the sum of estimated proved plus probable reserves.* (less certainty than Proved Reserves)

POSSIBLE RESERVES (3P) – *those unproved reserves which analysis of geological and engineering data suggests are* ***less likely to be recoverable than probable reserves****. At least* ***10% probability*** *that quantities actually recovered will equal or exceed the sum of estimated proved plus probable plus possible reserves.* (least certainty)

In other words, prospective and contingent resources refer to oil & gas that might be recoverable but not in the present day, possibly due to technological constraints or circumstances (eg. insufficient oil price, excessive production cost, regulatory restrictions). **Investors ought to place most emphasis on 1P Reserves; anything beyond (2P, 3P etc) is considered speculative and based more on hope than facts.**

Company presentations might also highlight "PV10" or "PV15". PV10 is the present value of estimated future oil and gas revenues discounted at 10%, and net of direct expenses; vice versa for PV15. These ballpark figures are nonetheless estimates, and often do not adequately reflect the high risk of undeveloped reserves (many things can go wrong between the many phases of planning to production).

3. Exploration Process

In short, geography matters. Crude oil is often discovered near known producing areas, where similar environment (heat, pressure) encourages its formation, and then geology enables the subsequent entrapment. It is no coincidence that Eagle Ford and Bakken plays each makes up 10% of US proved oil reserves. By some estimates, **there is a low 10-15% chance of discovering oil in a location where oil has never been found, vs 50% or higher success rate where there is precedence.**

In most instances, the first step begins with the bidding for concessions that grants the successful bidder rights to explore and produce, and details specifics such as boundaries and lease duration. At this preliminary stage, geologists will analyze the tender data to look for telltale signs of oil reserves – conventional reservoirs require sufficient depth for heat and pressure to turn hydrocarbons into crude oil, porous reservoir rocks for crude oil to accumulate over millenniums, and lastly an impermeable layer of rocks on top of the porous formations to trap the oil and prevent it from escaping to the surface (where it would degrade instead).

A clearer picture emerges when the successful bidder conducts a seismic study, whereby seismic waves are projected, bounced back, and collected (similar to echoes). This data, when analyzed, reveals different underground layers and depths and can be used to map out the oil reservoir, enabling scientists and engineers to make educated guesses of where to drill to confirm or reject their hypotheses.

Drilling is the only way to confirm the presence of hydrocarbon, whether it exists in sufficient quantities, and eventually to decide on continuous extraction. This is done by deploying drilling rigs to drill either on land or in the open sea (further differentiated into jack-up, semi-submersible and drill ship). Land rigs typically cost less and are faster to deploy, but newer reservoirs are increasingly discovered in deeper waters, hence inflating the cost of drilling and subsequent production.

4. Production Rate (boe)

Production Rate refers to the no. of barrels of oil (bbl) or barrels of oil equivalent (boe) pumped out of the wells per day. 1 bbl oil = 42 US gallons = 159 litres. After the initial optimization and ramp-up, oil production will decline over time due to the gradual drop in pressure – unless various recovery techniques are utilized.

1 boe = Amount of energy released by burning 1 bbl oil = 5.8×10^6 BTU, and roughly equivalent to 6,000 cubic feet of natural gas (6 mcf). However, 1 bbl oil doesn't sell for the exact same price as 1 boe. As of 25 June 2014, WTI Crude Oil trades at $106.44/bbl, while NYMEX Natural Gas trades at $4.53/mcf (ie. $27.18/boe). **Therefore, even though 1 bbl = 1 boe in terms of energy, 1 bbl ≈ 4 boe in price.**

As such, it is vital to know the proportion of oil and gas produced, so as to correctly categorize the producers and understand their corresponding economics. In general, crude oil has higher margins, and is easier to transport, store and process. All things equal, production rate increase = higher revenue = better scale & profits.

5. Enhanced Oil Recovery

Not all oil can be pumped out of the well. Oil production takes place over 3 phases:

Primary Oil Recovery

Natural pressure of the reservoir or gravity drives oil into the wellbore. This pressure, combined with artificial lift techniques such as pumps, transports oil to the surface. 10% of the reservoir's original oil in place is recovered this way.

Secondary Oil Recovery

As the pressure is relieved, less oil flows out by itself. Injection of water or gas displaces the heavier oil and drives it to a production wellbore where it is brought to surface. 20-40% of the reservoir's original oil in place is recovered this way.

Enhanced Oil Recovery (EOR)

By the time secondary techniques fail to induce more oil production, there is still up to 70% of original oil left in the reservoir. EOR (thermal steam or gas injection that aims to lower viscosity and improve flow rate) has the potential to ultimately extract 30-60% of the original oil, but are more costly than primary and secondary techniques and thus requires higher oil prices to achieve a reasonable ROI. Given that crude oil prices have risen 10-fold in the last 15 years, many oil producers have found it economical to deploy EOR on oil fields that were near abandonment.

6. Cash & Non-Cash Costs

As with all industries, not all expenses are cash. Cash expenses typically consist of lease/well operating expenses, production taxes, general & administrative expense, as well as transportation & gathering expense. An oil producer might make GAAP losses, yet generate cash flows to organically fund huge capex, due to "depletion".

Background: Reserves are carried on the balance sheet at acquisition, exploration or development cost. While PPE (property, plant and equipment) is depreciated when in use, reserves are subjected to "depletion" when extracted, ie. a non-cash expense that reduces the reserves' carrying value to reflect lower economic value going forward. **In other words, "depletion" represents the expensing of historical sunk cost, and thus bears little relevance to future production economics,** although that might be indicative of the management abilities. Furthermore, dip in oil prices have a double whammy effect of lowering oil sales revenue while increasing depletion non-cash expense (less reserves can be profitably extracted).

7. 1P/Production Ratio

This ratio calculates the amount of reserves that can sustain today's production rate if it remains constant. If this ratio is low, that spells danger as there is lesser revenue visibility and the company might be reckless in increasing reserves. On the other hand, a high ratio typically is good as there is plenty leeway to increase production and monetize its reserves. That being said, this ratio doesn't distinguish between proved reserves with low or high production cost, and how much additional capex needs to be set aside in order to scale up the production rate.

8. Exploration Success Rate

Reserves are obtained via exploration or M&A. The former tends to cost lesser, but also comes with higher risk of failure ie. drilling a dry or underperforming well. **Exploration Success Rate gives an idea of how successful the exploration activities are, and whether the company has long track record of finding oil or hitting duds.** A sound company cautiously manages its capital budget and maximizes success rate by drilling only after thoroughly exploring all options. On the other hand, if the company consistently has low success rate, expectations might already be low – occasional discoveries could lead to re-rating and surge in share price.

9. % FCF to Capital Expenditure

According to EIA, for the period of 2007-09, finding costs have spiralled upwards to $41.51/bbl for offshore reserves in the US, even though crude oil once traded at ~$10/bbl. **It costs an average of $4 million to drill a crude oil well in 2007**, up nearly 800% from $445,600 just ten years ago, and presumably more today after factoring in inflation and complexity of new discoveries. MNCs might have the finances to commission an oilfield, but smaller players would struggle to fund the high capex. The more oil production they currently have in place, the lesser the need to tap the capital markets for expensive debt or dilutive equity fundraising.

Decade	Year-0	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8	Year-9
1960's	52.2	51.3	54.2	51.8	50.6	56.6	62.2	66.6	79.1	86.5
1970's	86.7	78.4	93.5	103.8	110.2	138.6	151.1	170.0	208.0	243.1
1980's	272.1	336.3	347.4	283.8	262.1	270.4	284.9	246.0	279.4	282.3
1990's	321.8	346.9	362.3	356.6	409.5	415.8	341.0	445.6	566.0	783.0
2000's	593.4	729.1	882.8	1,037.3	1,441.8	1,920.4	2,238.6	4,000.4		

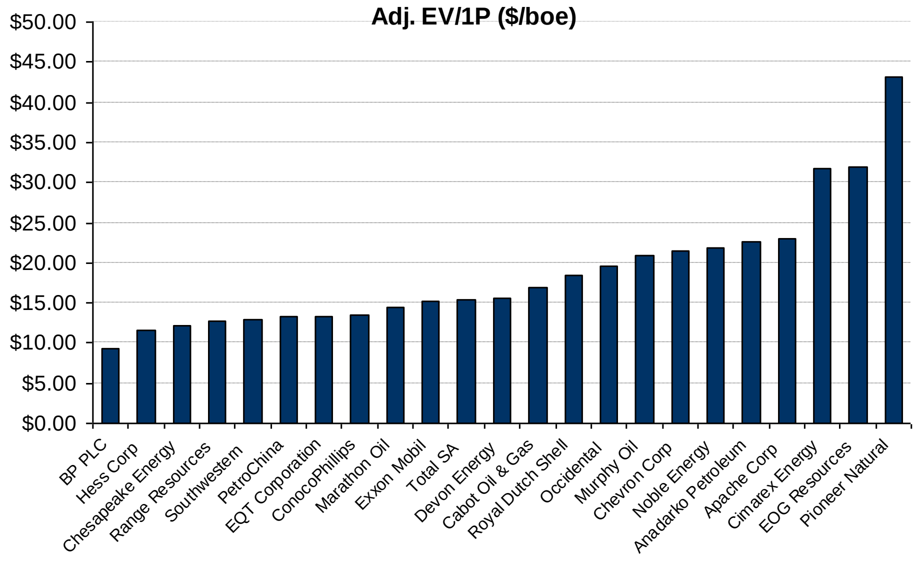
Source: EIA US Nominal Cost per Crude Oil Well Drilled ($'000s per well)

% FCF to Capital Expenditure is an indication if the company is capable of organically funding its projects, but not an exact science as the company could also increase FCF (higher oil prices or production), or cut back on its capex budget.

Other way to raise funds are asset/royalties sale, or entering into strategic agreements where another partner would obtain a stake in the oilfield in exchange for funding some or all of the drilling costs. Again, such manoeuvres might or might not be in the best interest of shareholders; while they do lower operational and financial risk, shareholders might benefit more if they wholly owned the project.

10. Identifying Top Picks

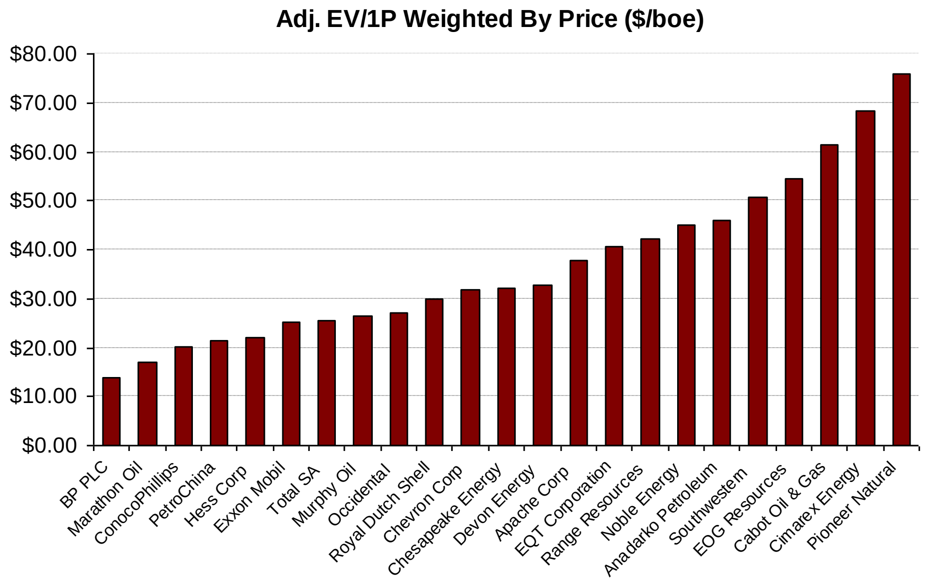
It is hard to compare companies simply on the basis of their E&P assets, as the bigger oil majors are often vertically integrated and would own refineries, marketing & distribution etc. Nevertheless, for the purpose of this report we shall focus only on their E&P assets and rank their attractiveness according to proved reserves (1P) (and the reserve mix), production rate and dividend yield. Any pre-tax income not attributable to production would be capitalized at conservative 7x, then deducted from EV to better reflect the value of exploration & production assets.



EV/1P is a measure of Enterprise Value (EV) per barrel oil equivalent (boe) of proved reserves. The lower this metric is, the cheaper the investor is paying for reserves. After all, this is what E&P is about – paying as little for as much reserves in the ground as possible, and which has higher certainty of extraction.

Many reports would stop here and simply highlight the lowest EV/1P, however this does not adequately address the fact whether these reserves consist mostly of gas, oil or NGL. As discussed earlier, 1 bbl oil = 6,000 cubic feet of natural gas (6 mcf) ≈ 4 boe in price. Hence, $20 EV/1P might look cheap at a time when 1 bbl oil sells for $100, but expensive if 1P is mostly natural gas (6 mcf sells for $27.18).

If we adjust EV/1P based on the selling price (1 bbl oil = $106.44, 1 boe natural gas = $27.18, 1 boe NGL = $35), we'll arrive at the following chart.

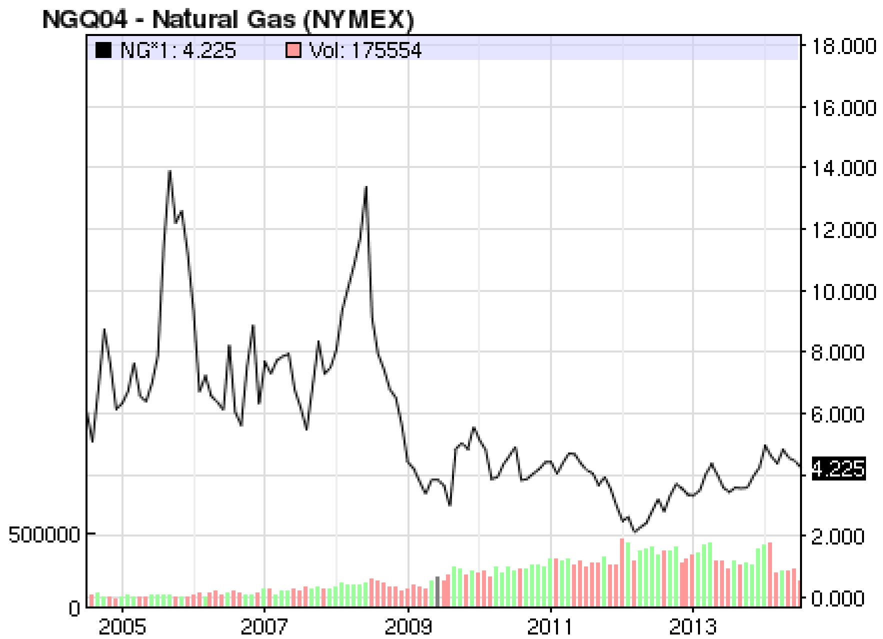


A clearer picture now emerges – when the proved reserves are weighted by selling price (ie. equal to that of 1 bbl crude oil), **BP PLC, Marathon Oil, ConocoPhillips, PetroChina and Hess Corp are among the Top 5 with the cheapest EV/1P.** In other words, for these five companies, investors are paying less than $25/bbl for oil & gas reserves that today sell for more than the equivalent of $100/bbl when produced.

That being said, investors who are long-term bullish on oil & gas resources might instead want to bet on companies with the highest weighted EV/1P, as they are way more sensitive to price increase. For instance, Company A is currently earning 1% margin. If its revenue increases 2% without corresponding increase in expenses, Company A would now earn 3% margin, hence effortlessly tripling its profit.

High EV/1P could also mean that their proved reserves have low production cost, or a successful track record of adding proved reserves, or heavily geared towards natural gas, but these factors cannot all be accounted for in the same equation. Cabot Oil & Gas, while having the third highest weighted EV/1P at $61.43/boe, has increased its proved reserves by 42% y-o-y, and 97% of its proved reserves are in natural gas. Hence, investors would do well if they use EV/1P as a first cut, then investigate further to understand individual dynamics driving the share price.

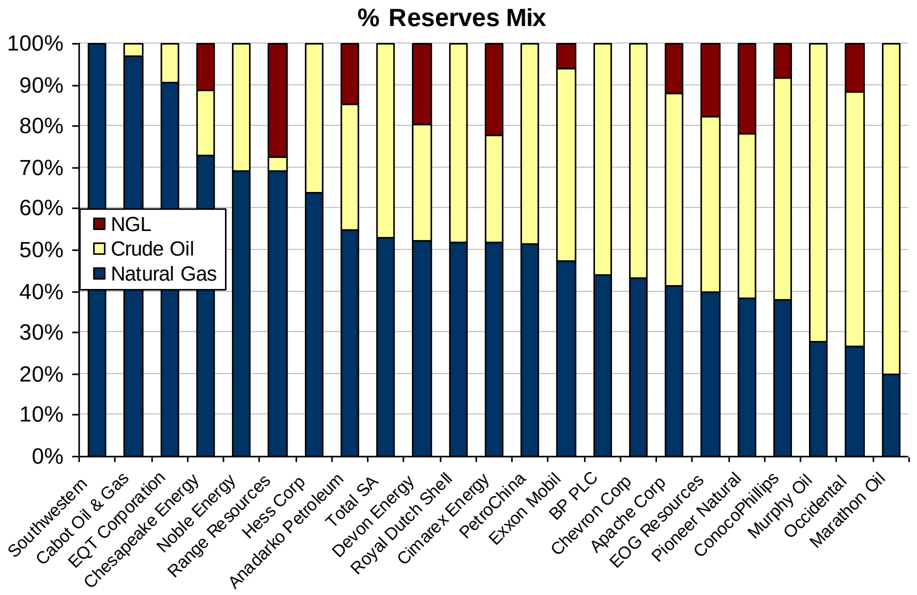
Another way to play the oil & gas sector is by identifying the type of reserves they own. As previously mentioned, the start-up of LNG export plants might possibly reduce the glut of shale gas supply in US, with the effect of increasing selling price. At $4.225/mcf, it is hovering near historical lows when compared to 2005-08 period, where it traded above $6/mcf for most of the time, even spiking to $14/mcf.



Source: US National Average Natural Gas Price

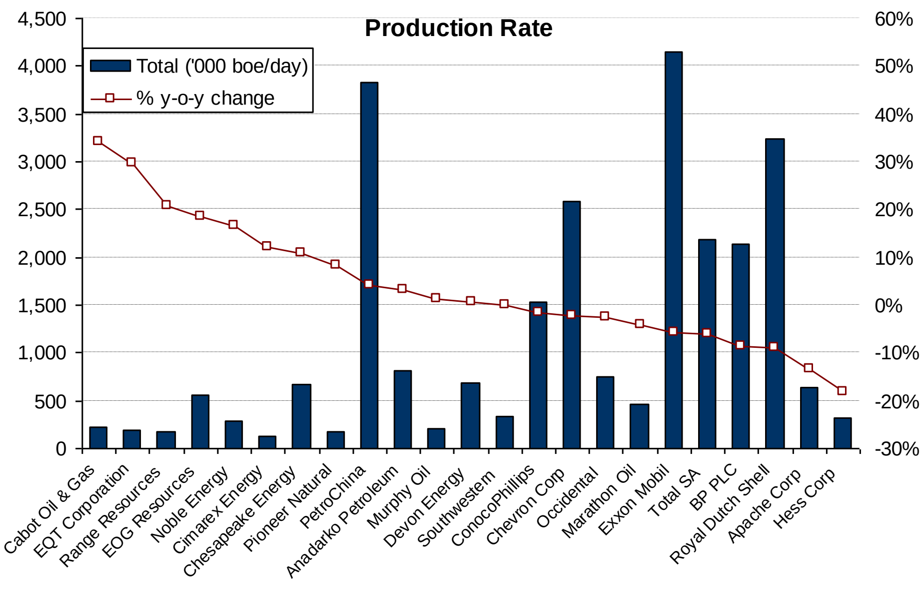
On the contrary, LNG prices in Asia have risen to all-time high of around $14/mcf, primarily due to the Japan Fukushima disaster that led to a shutdown of all nuclear power plants, thus increasing the demand for natural gas as a feedstock for its other electric power plants. Given the price gap of nearly $10/mcf, there is plenty of money to be made exporting natural gas out of US into Asia, notwithstanding the high cost ($3/mcf for liquefaction into LNG, on top of $3/mcf for shipping).

Investors who believe that natural gas price would converge, resulting in higher US natural gas prices, might want to ride the LNG wave by shortlisting companies who hold the most % reserves in natural gas. However, do note that not all reserves are located in the US, thus the pricing difference might be smaller. In addition, natural gas is difficult to transport over long distances in its gaseous state; in the absence of LNG export plants, natural gas production can only be consumed domestically.



Southwestern, Cabot Oil & Gas, EQT Corporation, Chesapeake Energy, and Noble Energy round up the Top 5 in terms of highest % Reserves Mix in natural gas. Impressively, 100% of Southwestern proved reserves consist solely of natural gas.

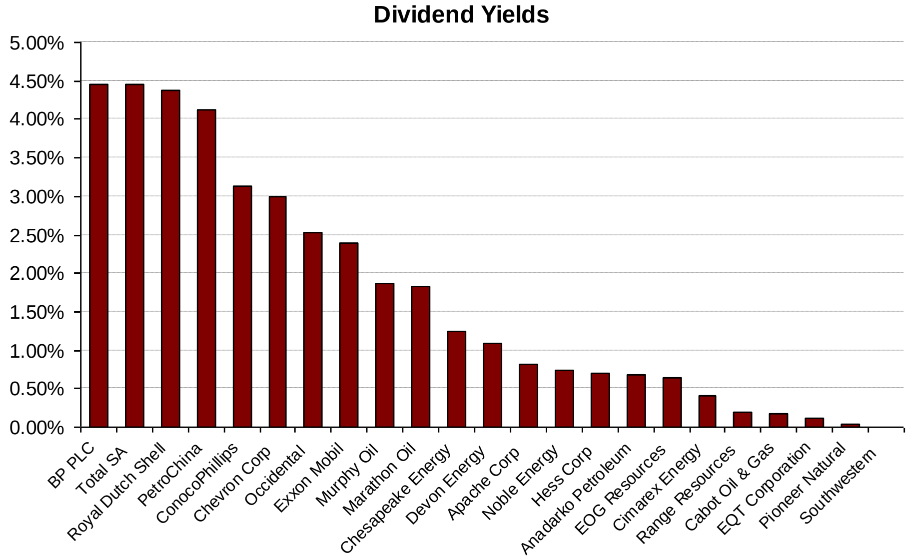
Conversely, investors betting on crude oil price fundamentals should instead look at **Marathon Oil, Murphy Oil, Occidental, Chevron Corp and BP PLC**, whose crude oil reserves (inclusive of some oil sands) range from 56-80% of overall reserves.



Next, investors might want look at companies with increasing production rates, as that would translate into higher revenue growth and better economies of scale. It's interesting to note that 9 out of the 10 producers with highest production growth rate each average less than 500,000 boe/day. Familiar names such as ConocoPhillips, Chevron, Exxon Mobil, BP and Shell are all experiencing production declines. That being said, one should not jump to conclusions as that could result from asset divestures, whose capital can be recycled into higher return projects.

Top 5 Producers (Highest Production Growth Rate) are Cabot Oil & Gas, EQT Corporation, Range Resources, EOG Resources, and Noble Energy.

Lastly, buy-and-hold investors who are primarily concerned with steady income stream, would be interested at dividend yield (which tend to be more predictable and rarely cut). Singaporean investors are disadvantaged in the sense that US dividend income is subject to 30% withholding tax rate. Not surprisingly, the top 5 stocks with highest dividend yields are oil MNCs, who have access to capital markets, productive reserves, and often supplemented with downstream assets, comprising of **BP PLC, Total SA, Royal Dutch Shell, PetroChina, and ConocoPhillips.**



In all, here is the list of top picks for different types of investors. Traditional metrics such as P/E and P/B are less relevant to E&P producers, as their value lie in their reserves (not revenue generating), and the carrying value for the oil & gas reserves has nothing to do with actual worth (ie. profitability of future production).

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3. Royal Dutch Shell (NYSE: RDS-A)
4. PetroChina (NYSE: PTR)
5. ConocoPhillips (NYSE: COP)

Once again, this is a simple shortlist based on the above reasoning and calculations. Investors are encouraged to conduct their due diligence and thoroughly research the fundamentals of each company before investing. Alternatively, one can also diversify into a basket of many stocks to lower the risk from individual companies.

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