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Briefing note

Investment in Oil and Gas: The impact of climate change

A view from the Finding Petroleum 'Investing Under a Carbon Cloud' discussion

On 19 November 2015, anticipating the COP21 Paris climate summit in January 2016, Finding Petroleum held a wide-ranging conference in London. Given the topicality of climate change policies, a glut of oil, and low commodity prices, what impact will these have on the outlook for investment in oil and gas over the next few decades?

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David Bamford, of Finding Petroleum and Teng Ben of Bernstein Research opened proceedings by suggesting that emerging climate change policies could be the biggest threat to the oil and gas industry; more important than the impact of current low commodity prices, which unlike climate change could be very temporary.

Some key reports have been published recently. BP has published their Energy Outlook 2035, and the sixty-fourth edition of their Statistical Review of World Energy. The International Energy Agency (IEA), based in Paris, published their World Energy Outlook 2015, which takes government and energy company statistics and forecasts the outlook on the year 2040 based on world population, regional energy demand and supply and what the energy mix might look like.

> *The most likely path for carbon emissions, despite current government policies and intentions, does not appear sustainable… No single change or policy is likely to be sufficient (to achieve the base case target of limiting anthropogenic global warming to 2°C above pre-industrial levels)… and identifying in advance which changes are likely to be most effective is fraught with difficulty.*
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> **BP comments in the Energy Outlook 2035**

From an oil and gas industry perspective, much attention has focused on the emissions of CO_2 arising from use of fossil fuels, and the possibility that policies to limit these, such as an enforced physical 'carbon budget' approach, or taxes on carbon emissions, could render many reserves uneconomic or 'unburnable', so they would become in effect 'stranded assets.'

A further presentation gave the view that the greatest threat to the oil and gas industry is the lithium ion (Li-ion) rechargeable battery, rather than low commodity prices. This view is very popular with advocates of solar power, who point out that significant progress has been made in developing this technology and cutting costs – the case rests upon an assumption that battery capacity and cost reduction will continue to improve exponentially. Unfortunately perhaps, this is extremely unlikely. Li-ion batteries are subject to 'parasitic reactions'. In each charging or discharging cycle these reactions degrade and destroy the organic electrolyte through which lithium ions must flow from one electrode to another. Battery lifetime is therefore limited, as must be apparent to everyone who uses a smartphone. The rate of progress in research to overcome this problem is slowing rapidly, as physical limitations of the technology begin to bite.

> After 2030, emissions will have to be maintained at 25% below their levels in 2000 if a 2°C limit on global warming is to be achieved.

Winifred Wilcke and Ho-Cheol Kim of the Institute of Electrical and Electronics Engineers (IEEE) point out that in the long run, new Lithium-Air battery technology may offer much better costs, capacity and lifetime. For now, Li-ion batteries cost $200 to $300 per kilowatt-hour, which means it costs about $40,000 to produce a (very heavy) Li-ion battery large enough to give an electric car a 500-mile range. It will be many years before any lithium battery capable of supporting this range for a car could be commercially viable, and the challenges for electricity grid use are considerably greater. Notwithstanding this, the BP report predicts that solar power will be by far the most important renewable by 2040.

CO_2 emissions and global warming

Given an assumption that other factors influencing the climate remain equal (which is very much unproven), the relationship linking increased CO_2 emissions with global warming is now considered to be well understood. We can estimate the amount of warming which can be expected if CO_2 emissions continue at various specified levels until a future time: for comparison purposes this is usually 2100. The likely impact of various policies or changes in technology on global warming can be assessed using these estimates as a benchmark. The likely *economic* impact of different levels of warming is less understood; much more research in this area is needed, at local, national as well as at global level.

Bernstein's presentation indicated that there are 2,514 gigatonnes of CO_2 contained in current proven reserves of fossil fuels, of which 616 gigatonnes are in oil, 349 gigatonnes in gas, and 1556 gigatonnes in coal.

Based on the 'New Policies' scenario for climate change policies suggested by the IEA, the following shows an estimated relationship between CO_2 emission levels and climate change:

50% Probability of Maximum Temperature Rise (Degrees Celsius)	Gigatonnes Carbon Dioxide Emissions Allowable between 2014 – 2100, corresponding to targets		
	GT CO_2	GT CO_2	GT CO_2
	2014-2049	2050-2100	Total 2014-2100
1.5	430	25	455
2.0	980	475	1455
2.5	1180	1176	2356
3.0	1330	1875	3205

Source: Meinshausen et. al. (Nature), Bernstein Estimates

For comparison, it is estimated that 1980 gigatonnes of CO_2 have been emitted in total from the pre-industrial period until 2014.

Under a uniform carbon budget targeting 2°C warming, about 42% of these 'carbon emission' reserves would be unburnable stranded assets. For the oil and gas industry, according to Bernstein and the BP Statistical Review, stranded assets are not an issue for natural gas, but are an issue for some oil producers, with heavy oil and Organization of the Petroleum Exporting Countries (OPEC) most impacted. 60% of proven coal may be stranded, but only 20% for oil and 0% for gas.

These estimates are at a global level and assuming uniform implementation of a global limiting budget for CO2, based on physical emissions, not on economics. Looking at this from a national or corporate level, for the top 50 producers, 192% of remaining proven oil reserves and 206% of gas reserves would not be stranded under a carbon emission budget for 2°C warming, and many heavy oil assets are marginal anyway, for economic reasons.

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An achievable 2°C warming limit?

Bernstein does not think the 2°C limit is really achievable without an accelerated shift in the global energy mix. Global CO_2 emissions are highly correlated with primary energy demand growth, which in turn is highly correlated with Gross Domestic Product (GDP) growth per person and population growth.

According to BP, China and India are key drivers of non-Organisation for Economic Co-operation and Development (OECD) growth in GDP, and are projected to grow by:

PER ANNUM BETWEEN 2015 AND 2035

By which time they will be the world's largest and third largest economies respectively. Jointly, they will account for about a third of global population and GDP.

Based on submissions to COP21 by individual national governments prior to the Paris conference, carbon emissions (mainly CO_2 but also including methane, CH_4) will continue to grow until 2030. China has pledged that its emissions will peak by 2030. By 2030 China, already the world's largest source of emissions, will account for about 29% of the world total, assuming the submissions to COP21 are implemented from now onwards. After 2030, emissions will have to be maintained at 25% below their levels in 2000 if a 2°C limit on global warming is to be achieved.

The targets and policies emerging from COP21 will be implemented at national level, with varying degrees of commitment and effectiveness, and a more liberal approach is expected from 'developing' countries, given the greater pressure on their governments to increase the standard of living. The assignment of 'developing' status to countries derives from a conference in Prague in 1992, and should be reviewed, according to the UK and other 'developed' countries. Of the six largest sources of CO_2 emission in 2015, only the USA is considered 'developed'. The other five are China, India, Russia, Indonesia and Brazil; four of these are among the ten largest economies in the world. India is expecting its demand for energy to increase by 40% from 2015 to 2040.

Driving lower carbon emissions

Without sacrificing global GDP growth, three factors will drive lower carbon emissions according to Bernstein. In order of importance they are energy efficiency, the energy mix (of primary sources), and 'other' factors such as carbon capture and storage.

The BP projections agree with this view, though with more emphasis on declining energy intensity rather than efficiency, as economic growth becomes less dependent on heavy industry.

ONLY ABOUT

of the CO_2 emissions associated with oil and gas occur during Upstream (exploration and production), refining, distribution and marketing ('well to tank')

A FURTHER

of total emissions occur when the fuel is burnt

For this reason, improvements in the efficient use of oil and gas are likely to be more effective than changes within the industry itself.

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> Ten global oil and gas CEOs have called for a global carbon pricing system and for gas to be part of the solution to lower carbon emissions, including European majors, Saudi Aramco and Pemex, but not US majors.

According to Bernstein, while improved energy efficiency and other technologies might help, switching to gas is our most likely bridge to a low-carbon future. As the carbon intensity of energy from coal is about 65% greater that of gas overall (and two to three times greater for direct electricity generation), replacing coal with gas in electricity generation and other (non-transport) uses, and 20% of oil in transport would be one pathway to lower CO_2 emissions.

Continued demand for oil and gas

Given this picture, demand for oil and gas is expected to continue to grow for the foreseeable future (at least until 2040). Natural gas is expected to be the fastest growing fossil fuel, with growth in oil marginally ahead of that for coal. Demand for coal - currently the cheapest, most abundant and dirtiest fossil fuel - is expected to grow by about 20% by 2035, and by much more than this in China.

According to BP, world demand for oil is expected to grow from 94 to 110 million barrels per day between 2015 and 2035. Other projections (by OPEC, Exxon and the IEA) differ slightly but all point to a similar outcome. For the UK, given current policy objectives, estimates indicate that fossil fuels will supply at least 70% of total energy until 2030 and beyond.

As existing fields are depleted, oil and gas production will always tend to decline unless exploration continues to replace reserves. This trend will become more important as the role of coal declines; coal accounts for most of the CO2 contained in proven fossil fuel reserves. At time of writing the Brent Crude Oil benchmark is at $40.79. Replacing natural decline of 18MMbbl/d over 3 years would need >$80 oil, not $60 to $70 as at current costs. Chris Wheaton of Allianz Global Investors asks if such an outcome would be acceptable yet, politically.

Producing more energy

Overall, the world will need to produce more energy, but with lower environmental impact; this will have to be achieved by more efficient energy use, replacing coal with gas, using Carbon Capture and Storage (CCS) at power plants, and using more renewables and nuclear energy.

According to Bernstein, renewables and other alternative energy sources remain uneconomic relative to gas at today's prices, unless the market is adjusted by subsidies and taxes. Nuclear power is cheaper than natural gas only in China. To make gas competitive relative to coal, a global carbon tax should be introduced; this would strongly favour natural gas and LNG producers over oil producers. Any such tax would also favour low-cost producers such as Saudi Arabia, but discourage high-cost production such as Canadian heavy oil.

According to Professor Rob Socolow of Princeton University, a global CO_2 tax of $100 per tonne of atmospheric CO_2 emission is roughly equivalent to a tax of:

*one million British Thermal Units

> “Pursuit of the ‘marginal barrel’ in high-cost environments has been very expensive; investors want greater emphasis on technology and efficiency.

According to company reports and Bernstein analysis a $100 per tonne tax would equate to between 30% and 40% of group operating income for Exxon, Shell, BP, Conoco and ONGC, but much less for operators such as PEMEX, BG (now part of Shell), Woodside and Statoil.

Oil majors have been responding to climate change policies, positioning themselves as providers of primary energy sources (including renewables) rather than just hydrocarbons. Shell and TOTAL have been the most active.

Global carbon pricing

Ten global oil and gas CEOs have called for a global carbon pricing system and for gas to be part of the solution to lower carbon emissions, including European majors, Saudi Aramco and Pemex, but not US majors. Shell and BP have both called for a $40 per tonne rate for major investment decisions, as they regard certainty as an important factor in long term planning. They recognize that current greenhouse gas emissions were inconsistent with the goal of limiting global warming to 2°C, and that new technologies need to be developed such as CCS.

CCS

Several major energy companies (BP, Chevron, Petrobras and Suncor) set up a CO_2 CCS project as a partnership in 2002. It provides a unique, collaborative forum for those companies to develop practical CCS knowledge and solutions that relate specifically to the oil and gas industry.

Since 2000 the CO_2 Capture Project (CCP)’s expert technical teams, made up of engineers, scientists and geologists from member companies, have undertaken well over 150 projects to increase understanding of the science, economics and engineering applications of CCS.

In that time, the CCP has worked closely with government organizations - including the US Department of Energy and the European Commission, and more than 60 academic bodies and global research institutes. It has been recognised by the Carbon Sequestration Leadership Forum (CSLF) for its contribution to the advancement of CCS. Its activities are monitored and reviewed by an independent technical advisory board made up of CCS industry experts. Phase three of the project aims to ‘Demonstrate technologies that will reduce the cost and accelerate deployment of CCS.’

CCS development

The UK has been taking a lead in the development of CCS technology; existing heavy industries in Teesside have been collaborating to develop a shared infrastructure for CCS. Most of the captured CO_2 would be stored in exhausted reservoirs under the North Sea, or (more productively) used for Enhanced Oil Recovery (EOR). However CCS remains expensive; the business case for the Teesside project is dependent on a contribution from public funds, which have just been withdrawn. The UK government has also decided to cancel support for a CCS project at Peterhead, and a £1 billion competition to support CCS research.

The industry view is that this is unfortunate, as CCS technology is best developed by ‘learning by doing’ rather than theory. If the Peterhead project goes ahead, it would be the first full-chain gas CCS project on a commercial scale in the world, however it is unlikely that Shell, which planned to capture about 90% of the CO_2 emitted by one of the gas turbines at Peterhead power station (for zero commercial return) will now go ahead with it.

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Recycling CO_2

There are other, more optimistic uses for CO_2 (in effect recycling it and adding value) under development. In the USA, researchers are developing artificial trees which will capture CO_2 and emit oxygen, much as natural trees do but more efficiently. At the University of California, researchers are developing photosynthesis as an industrial process, turning water and CO_2 into sugar and other products useful as fuels and chemical feedstock.

> *I want oil companies to grow profitably in the future - that may mean limiting growth to <2%. I want companies to focus on Return on Captial Employed (RoCE) and cash flow per share and to focus on longer-term risks to the business models.*
>
> **Chris Wheaton of Allianz**

Pursuit of the 'marginal barrel' in high-cost environments has been very expensive; investors want greater emphasis on technology and efficiency.

According to Allianz Global, carbon taxes would be a lose/lose outcome. A $20/bbl impact from carbon tax imposed on oil companies would reduce post-tax return on capital employed for the industry by about four percentage points; that is, by about one third, assuming RoCE recovers from currently low levels back to 'normality' by 2018!

This is an unattractive outcome for shareholders and oil consumers too because it would guarantee a return to $100 oil as the industry fights to survive, and cuts investment.

In conclusion, BP expects a continued emphasis on technologies such as seismic imaging and EOR in the short term. Oil recovery rates well in excess of 50% of oil initially in place are now in prospect thanks to EOR technologies, and new technologies such as using electrical pulses for shale gas recovery look promising.

Please contact the Head of our Oil and Gas Consultancy, Iain Poole if you would like to discuss any of the above topics in more details.

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