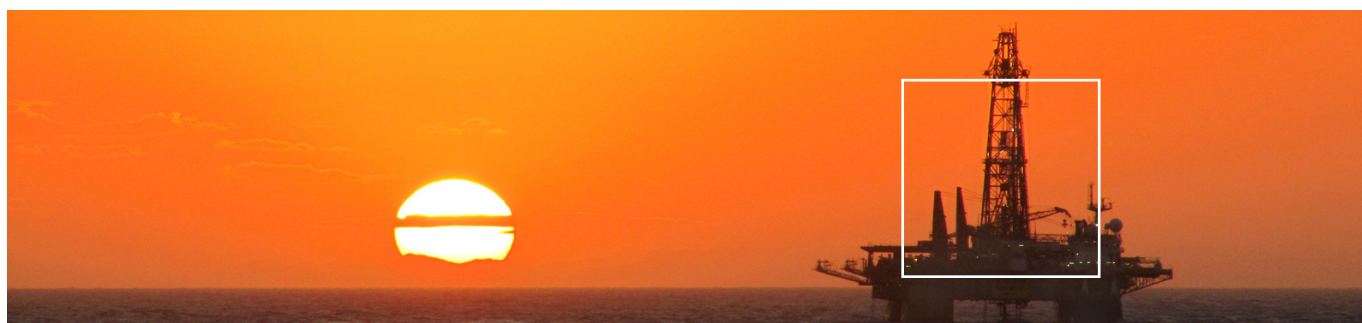


Where now for oil?

Recent market turmoil is not likely to last – a new normal is in the making for oil and gas prices



The impact of shale oil and gas on the world's energy market over the past five years has been well documented, but few, if any, forecasters predicted the precipitous fall in energy prices seen in 2014. In this viewpoint we attempt to explain the economics of the change and highlight an emerging "new normal" for oil prices in which a medium term recovery occurs, but prices stay below US\$80 per barrel (WTI¹). We also highlight the implications of this new normal.

Introduction

The recent precipitous fall in the oil price – predicted by almost no-one – has proved to be highly dislocating for many companies and left them searching for answers as to why the fall has happened, when (or if) prices will recover, how much they will recover by, and how fast.

On one level the fall is a classic supply-demand story – weakening demand and burgeoning supply has led, at least temporarily, to a glut of oil. Yet underlying this is a deeper story, one of dramatic technological change that has changed the "rules of the game". Technological innovation in fracking and drilling has enabled the United States to perfect the cost-effective production of oil and natural gas from hitherto unrecoverable reserves, transforming US hydrocarbon production.

While extensively discussed, we believe that the impacts of this technological revolution are still underestimated by many. With technological advancements still proceeding at a rapid pace, the break even costs of extraction continue to fall, reducing the likelihood of a rapid rebound to prices in the region of \$100 per barrel. Instead, Arthur D. Little's analysis of the fundamentals points to a likely "new normal" which brings a lower equilibrium price range of \$70-80 per barrel. Here we explore the changes to the fundamentals which lead to this conclusion.

Oil: Too much of a good thing

While growth forecasts have diminished, global oil demand remains healthy and is predicted to continue to grow at around 1% per year for the foreseeable future. Instead the key to understanding the recent oil price collapse *lies in the supply*, in particular changes to the average cost of production which have promoted producers to boost volumes at higher margins with a result that supply has significantly outstripped demand for the past year or so.

A second key aspect is *where* this additional supply is coming from. Over the last decade, a higher oil price has encouraged the exploitation of a variety of new previously uneconomic resources, from Canada's oil sands, to Nigeria's offshore assets, Venezuela's vast heavy oil resources, to Brazil's deep water pre-salt reservoirs. High prices have pushed enhanced oil recovery (EOR) development, Japan's methane hydrates discoveries, as well as studies of the feasibility of production from the Arctic.

However, while all of these sources are potentially important, this story is dominated by something once thought of as a risky endeavor, but which has become a significant and highly competitive player in the global oil market: *US tight and shale oil*.

¹ WTI = West Texas Intermediate, a common benchmark crude. Throughout this article all price discussion relates to WTI in units of US\$ per barrel

US shale oil & gas: A revolution underpinned by a disruptive innovation

At the heart of the recent price collapse is a truly disruptive innovation – the extraction of hitherto unrecoverable “unconventional” oil and gas resources from shale formations using hydraulic fracturing (“fracking”), a technique pioneered and exploited primarily, thus far, in the United States.

The speed of with which development of fracking has made its impact has been nothing short of remarkable – initial deployment of modern fracking technologies only began in the late 1980s, yet in 2014 US tight oil production had grown to ~4 million barrels per day. To put this into perspective, this is four times the global Demand:Supply imbalance in 2014. The effects of this have been profound. Total US oil production is now on course to reach levels last seen in the 1980s and is set to match Saudi Arabian production. Gas production has seen a similar change. This astonishing turnaround – predicted by almost no-one ten years ago - has thrown global oil, gas and petrochemical markets into upheaval and **has disrupted, for good and bad, the strategies of many companies operating in the energy and petrochemical industries.**

The shale revolution is a classic example of a technology driven disruptive innovation which can rapidly alter established industry norms, and effect change much more rapidly than people expect. Arthur D. Little has a long experience of helping clients spot, assess and manage disruptive innovations which gives us particular insight into the transformational impact of this change on the industry. We will explore this in more detail in a follow-up article.

Continuing technological developments in fracking are changing production economics, limiting the potential for price rises

Far from abating, the fracking revolution has continued to develop at a rapid pace. Capex/EUR² for some US shale plays has dropped by more than 40% in the last two years alone due to technological improvements in proppants, sensors, imaging, drilling packages, and water management.

These innovations have substantially reduced the cost of tight oil extraction in the US. The estimated average long term cost of extraction for US tight oil plays is now below \$65 per barrel, while some prolific areas have a production cost of <\$40 per barrel, and the vast majority of plays have production costs of less than \$80 per barrel. These costs are expected to continue decreasing with time.

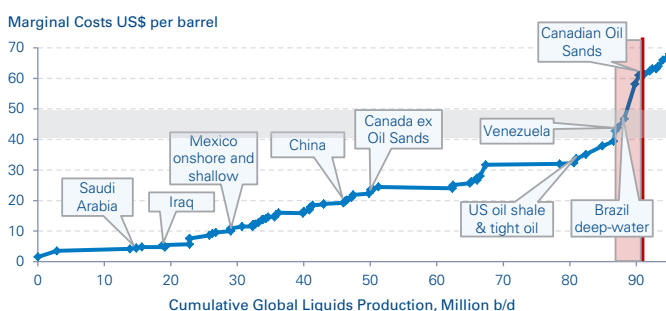
Since production levels from tight oil plays can be rapidly adjusted in response to market conditions, and estimated reserves are very large, the consequences of these low and decreasing costs are significant – any tightening of supply and consequent price rise from current levels would send a signal to US tight oil players to increase production and close the supply gap. **For these reasons US tight oil has effectively replaced Saudi Arabia and OPEC as the global swing producer, and US tight oil economics place a cap on the oil price in the near to medium term, in the absence of any geopolitical shocks or other unforeseen events.**

Based on this analysis Arthur D. Little does not expect that the price of oil will rise above \$80 per barrel in the next two to three years.

Nevertheless sub-\$50 prices are not likely to persist, unless politics intervene

The figure below shows the marginal costs³ of global oil production and shows that most existing fields can remain profitable in the short term, even at prices of around \$50 per barrel. In particular, the technological innovations referred to above mean that US tight oil plays can remain profitable (in marginal cost terms) even at oil prices of \$20-30 per barrel, much lower than was thought possible even a few years ago. This conclusion is supported by analysis of drilling rig rates. By July 2014, crude oil prices were sliding, yet minimal changes to production occurred until oil prices plunged below \$50 per barrel, at the end of 2014.

Marginal ('cash') cost curve for global oil production



Source: Morgan Stanley, EIA, Arthur D. Little

For these reasons we do not expect a sharp price rebound in the near term, unless OPEC producers cut production unexpectedly or geopolitical shocks ensue.

Nevertheless, a number of factors suggest that sub-\$50 per barrel oil is unlikely to be sustainable for long:

- Several high cost resources such as Canadian oil sands, ultra deepwater, Arctic, and unconventional basins outside US are already uneconomic *even on a marginal cost basis* at

² CAPEX/EUR is defined as net drilling and completion costs per well divided by net Estimated Ultimate Reserves (EUR) booked per well

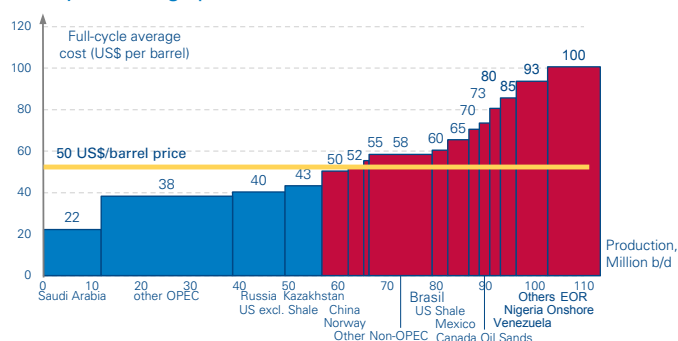
³ Marginal (or “cash”) costs represent the additional cost of producing another barrel once a field has been developed and is in production

current prices (see right side of above figure) and would be expected to be responding to the current price by reducing production (although given lengthy lifecycles, some time lag is expected).

- US shale plays suffer from high decline rates, which average 70% for the first year, making additional drilling a pre-requisite to maintain productions levels. The figure below shows the full cycle costs of production⁴ for a variety of global plays. This indicates that full cycle costs for US tight oil plays are generally above \$50 per barrel, meaning that producers will react to lower prices by cutting back on drilling and production. Indeed already some new tight oil projects have been delayed due to unattractive long term break even costs, and drilling rates suffered a record fall in January 2015.
- Some deep-water producers will maintain production levels since marginal cost for US Gulf Coast (USGC) fields can be as low as \$35 per barrel. However, the most prolific areas may delay investment into new projects because of the large CAPEX requirements, which average ~\$12 billion for deep-water USGC. In Brazil the current price levels will likely reduce investments by Petrobras, while West African projects also remain vulnerable as large international oil companies announce budget cuts.
- The Arctic is the newest and largest exploration frontier, with estimated resources of over 160 billion barrels but for obvious reasons is a challenging area to exploit. Several projects by oil and gas majors have already been put on hold.
- Whilst in principle the OPEC producers, in particular Saudi Arabia, could profitably supply market demand even at sub-\$50 per barrel oil, their fiscal situation makes this unlikely (it is estimated that oil prices of \$70-80 per barrel are needed for Saudi Arabia to balance its budget given current spending commitments).

For these reasons we believe that an oil price recovery to \$70-80 per barrel is likely over the next two years and that \$40-50 per barrel is likely to continue to provide a floor for oil prices. Indeed there are already signs that the oil price is

Full-cycle average production costs



Source: Arthur D. Little including published data from IEA

⁴ Full cycle costs represent the average cost of production over the lifetime of the field including all capital, operating and financing

starting to stabilize, although the picture is volatile and further supply shocks could push the price below this value.

Geopolitical forces add significant uncertainty

Global oil prices do not, of course, just reflect economic fundamentals but also geopolitical actions, risks (perceived and actual), hedging, speculation, and overall market sentiment. As such, making any predictions about the price of oil are always subject to significant uncertainty. Key sources of uncertainty include:

- Geopolitical aims - These continue to drive the decisions of key stakeholders. While the US appears to be targeting self-sufficiency and looking forward to fuelling its economy growth, other producers such as Iran, Russia, and Venezuela are under significant pressure to balance their fiscal budgets. The motives of major players are hard to read – domestic versus international priorities, short versus long term – with the result that predicting their actions is extremely difficult.
- Social & political turmoil – Several major oil producers have suffered from recent social & political instability. There is therefore a significant risk that turmoil in these countries would lead to a curtailment of supply. Indeed most oil price rallies in 2010-2014 were related to unrest in large oil suppliers from North Africa and Middle East (Libya, Syria, Iraq, etc.). Further conflicts in these regions will continue adding volatility.
- Large regional or global conflicts – A significant regional or global conflict would mean “all bets would be off” and a rapid return to >\$100 per barrel pricing would be back on the agenda.

Conclusion & Implications

We view that the dramatic increases in the productivity of shale oil & gas extraction has led to a “new normal” of oil pricing, and has effectively set an upper limit of \$75-80 per barrel in the near to medium term, unless unexpected geopolitical shocks intervene.

However, barring radical action by major oil producers, we do not feel that prices of below \$50 per barrel are sustainable, and that to stimulate the investments required to supply current and projected demand, **crude oil prices need to recover to ~\$60 per barrel by the end of 2015 and ~\$75 per barrel by the end of 2016.**

Such a price outlook would have a number of significant global economic impacts:

- **Upstream cut-backs and disruption** – NOCs are likely to make strong cuts in 2015 budgets, with those high break even producers (deepwater, oil sands) planning new large

Capex projects being especially affected. “Marginal” plays (e.g. ultra deep water, arctic, super heavy oil) become even more marginal. Opportunities for large scale M&A in energy sector will become more widespread.

- **Refining & petrochemicals positively affected** – Refining margins expected to recover from sharp declines in 2014 as product inventories ease. Petrochemicals to be benefited by cheap gas and naphtha, main raw materials; although product prices have also plunged.
- **Some global convergence of gas prices is likely...but the picture is complex** – There is no global gas price, regional gas prices are subject to a myriad of drivers, and the link between falling oil prices and gas price is complex. However, Arthur D. Little’s analysis suggests that in the short term US gas prices will remain low, while (partial) oil indexation will cause European and Asian prices to drop, leading to some global convergence (although a significant differential will remain). The extent of this effect depends on the strength of fundamentals: demand side changes including unpredictability through weather and substitution by other energy sources, while security of supply concerns may support gas price levels in the short term.
- **Some renewables may be challenged** – Biofuels will be increasingly uncompetitive and dependent on subsidy; some capacity additions will be delayed, and pressure to delay blending mandates will rise. Electric, hybrid, and fuel cell vehicle uptake will likely be delayed. Other renewables for electricity generation (such as wind & solar) should only be marginally impacted.
- **Some rebalancing of competitiveness between US and Rest of World (ROW) petrochemicals and chemicals** – The US will lose some of its competitive advantage arising from lower feedstock prices, allowing European and Asian players to compete more effectively, although a differential will remain.
- **New routes to petrochemicals & chemicals will be negatively affected** – Emerging approaches for the production of (petro)chemicals such as coal to chemicals and biochemicals will be negatively affected as naphtha based routes become more competitive. GTL will be compromised.
- **There will be regional winners and losers in the short term** – The winners of the current situation are mainly the large importers. Europe, Japan and China are benefited by cheaper energy imports and may see a significant boost to their economic growth. A price collapse will hit producers but may reinforce the idea of long term diversification in some Middle East and Latin American countries through more business friendly policies.

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The authors would like to acknowledge Kirsty Ingham, Salman Ali, Jaap Kalkman, Katia Valtorta and Yvonne Fuller for valuable input and discussions.

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