Paris Energy Club

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Summary of discussion

Session 1: Natural Gas and the demand for energy. Impact of new technologies and energy efficiency

Global natural gas demand is widely forecast to continue to grow, but at a lower rate than the 2.3% growth we experienced in the period from 2004 to 2014. There seems to be a consensus on a growth path around 1.5% per year. Among drivers of natural gas demand, the following factors are to be considered: comparative prices of coal and gas (coal is generally cheaper), cost of power from renewable energy sources (gas is more expensive), cost and availability of electricity storage to respond primarily to intermittency of power generated from wind and solar, extent of gas use as a back-up fuel for renewables, rate at which existing nuclear power plants are being decommissioned, government restrictions on coal-fired power to reduce pollution, government subsidies, taxation and carbon pricing policies, new and emerging technologies to meet emission reduction targets.

Potential gas supply is growing even more rapidly than the growth of gas demand. Pipeline trade is very important as trans-border existing pipeline capacity exceeds pipeline trade by about 130 bcm, mostly from Russia and from Algeria. Pipeline routes are being expanded and new ones are under construction, from Azerbaijan and Russia to Europe, from Turkmenistan and Russia to China and from Central Europe to Pakistan, India, and other destinations.

A new wave of LNG export capacity growth is anticipated in the medium-term, with about 160 bcm of new capacity led by Australia, 30 bcm and the US (90 bcm). Russia LNG1 has started and LNG2 is being considered, Indonesia Tangguh, the Coral project in Mozambique, the Malaysia FLNG, the Cameroon FNLG are planned, and Qatar intends to increase its capacity by 30% by 2024, while Iran has great exports' ambitions.

According to IEA Gas 2017 Report, the aggregate potential supply is expected to exceed projected global demand by 250 to 300 bcm by 2022, mostly in LNG form. Conventional wisdom is that the LNG market is likely to remain over-supplied to the mid-2020s at least. The surplus may prolong the period of depressed prices, almost regardless of the oil price level, as gas no longer competes with oil. As a result, inadequate future investment is expected to lead to new gas shortage in the long-term. LNG demand is growing, and international gas trade is back to its 2011 peak, while 2107 witnessed the highest growth in the LNG markets since 2010.

Experts say that the shortage risk was clear beyond 2023, and a massive supply gap is on the horizon. These considerations are based on the fact that there has been only one field taken for a large LNG Greenfield project since 2014, which was the Mozambique Coral project. Extension of brownfield projects may not be able to respond to the major gas demand that we see ahead.

Obviously, the question is at the time when we see the end of the oil glut, we may think that the gas glut can be handled the same way. The big difference is that there is no organisation that has the responsibility for ensuring market stabilisation efforts. There is no gas OPEC. Members of the Forum of Gas Exporting countries have made it clear from the beginning that they have no intention to act in any way on the supply side. Therefore, the only way to achieve balance would be to act on demand, which would require penetration of the new power generation market, investment in downstream infrastructure, power plants and FSRUs in order to reduce supply costs. According to some experts, there is a

potential for a 30% or 40% reduction in the costs of supplying LNG, particularly in the liquefaction process. We should also improve gas green credentials, by curbing CO_2 emissions.

This potential supply crunch comes at a time when the entire model for the international gas trade is in the midst of a big change. Previously restrictive sales contracts are being relaxed. Pricing models and price levels are changing. Regional gas prices have converged, but at a lower level. Many new LNG buyers are emerging, so gas exporters are increasingly demanding more flexible terms: short-term contract periods; smaller contractual volumes; flexible scheduling; wider take or pay bands; no resale restrictions; no destination restrictions. Gas exporters are probably unable or unwilling to coordinate the resistance to buyers' demands. In fact, they are competing with each other to protect market share.

There are some questions that have to be addressed. Exporters and importers have a mutual interest in neutralising excessive impacts of short-term imbalances on each other. They have to admit that they have reciprocal long-term investment in supply or demand security requirements. The question is, are buyers or sellers willing to forego individual short-term gains in favour of larger shared long-term benefits? Can contractual terms between buyers and sellers be devised in such a way as to cushion the impact of market cycles on both parties? How can the gas industry promote a better equilibrium of the global gas market? To what extent would a price on carbon emissions enhance the competitiveness relative to coal?

Gas market today is a buyers' market. Views on how long this buyers' market will last vary among experts. Some analysts see the gas surplus growing from 58 million tonnes per annum of LNG surplus today to 85 million tonnes per annum in 2021.

Gas producers are trying to find new outlets for such LNG surplus while being committed to pushing coal out of the generation mix, which is probably the low-hanging fruit. Instead of waiting for government policies to do the job, including on carbon pricing, the suppliers are trying to make gas competitive at different levels of the value chain.

Contracts duration is being reduced with some contracts for three years, but five to 10 years is definitely what we are talking about.

Oil indexation is still maintaining its market share in contracted export ; Asia, which is the largest gas buyer, is only moving down from oil indexation of 78% in 2016, and we are only expecting it to move down to 69% in 2022. Very creative proposals for pricing are to be mentioned: contracts with a ceiling ; discount to diesel is a matter of the past; market players are prepared to take a price risk compared to HFO ; trial period of FSRUs for free for three or five years ; containerised LNG that allows penetration of gas market with small LNG quantities using very small containerised LNG, which can be moved and plugged somewhere else.

Looking at power generation, solar and wind where first in class in terms of the volumes of net capacity added in 2016, but coal is only just behind. However, coal is still leading when we consider electricity generation (TWH) and will still be up to 2022. As a matter of fact, one quarter of the electricity is generated from coal but produces 80% of the emissions.

What is the solution to help phasing out coal? The solution is gas and renewables. Gas is abundant, flexible, reliable, dispatchable. When there is demand, gas jumps in. When renewables are not producing, then gas is there to deliver what is needed.

Is electrification the solution? However a lot of industries cannot do without gas as a feedstock and that cannot be replaced by electricity. According to the European Commission (report published on 30 November 2016), EU citizens pay three times more for electricity than for gas per kilowatt hour. Consumers are very much in favour of gas. A survey organised by BDEW showed that more than 43% of all the Germans surveyed preferred gas as heating energy; in the UK it is 80%. Sorry guys, but gas still has a lot to offer.

There is also a need to develop natural gas in transportation, including shipping, as it reduces NOX emissions by 80%, no particulates' emissions at all.

A full decarbonisation of the economy is required by 2050. For that, CCUS (Carbon Capture Utilisation and Storage) is a must. There is no choice and if there is one industry that can invest in CCS and CCUS, it is the oil and gas industry. The OGCI, the Oil and Gas Climate Initiative is doing a wonderful job at the moment and taking that very seriously.

In conclusion, gas is abundant, affordable for the decades to come and LNG is here to help. After Paris climate agreement, gas has to replace coal in power generation as soon as possible. Gas has a future in a low-carbon era; gas in transport makes sense, especially for long-haul shipping. After 2035 gas and CCUS become a must.

Session 2: The Geopolitics of Energy

For the last 70 years, the US used its power to help set up global institutions, such as IMF, the World Bank, OECD, WTO, the World Court. At that time, the United States was internally oriented to a large extent and then built regional alliances, not just NATO, but also with East Asian and Southeast Asian countries.

Such world order worked reasonably well, particularly for Europe, but was not very successful in the Middle East in the last couple of decades. It survived and actually reached its zenith in 1989, when the Soviet Union imploded. What we saw after 2000, was a challenge to the Pax Americana in every way, really coming from China. China is the emerging economic giant. The West, and in particular the United States, did not allow China to have a bigger voice commensurate with their economic power in the IMF and the World Bank. Subsequently, the Chinese set up their own new development bank, to provide at least USD 50 billion in development funding for developing countries. A year later, China founded the Asian Infrastructure Investment Bank, planning to invest 100 billion in new Asian infrastructure, the One Belt One Road Initiative, and many developed countries joined that bank. We see China playing a much bigger role financially and economically. It is a supergiant and for the first time, it is beginning to show all its military power particularly in the East China Sea and South China Sea, where again, China is not accepting the Western norms of the freedom of the seas, which go back to a 16th century Western concept. China want to be able to control the South China Sea and as much of the East China Sea as possible. We see this growing role of China militarily, growing stronger in the Pacific and China may soon be as strong, and finally stronger, than the US.

Another part of that is the emergence of Russia under Putin. In terms of economic power, Russia had the same GDP in 2016 as Spain, so it is relatively small at 1.3 trillion, dollars compared to China at 11.2 trillion and the United States 18.3 trillion. However, Russia too, particularly more recently, wants to return to its past position in geopolitical terms and have more of a say over the near abroad. Given the relative weakness of Europe, Russia has been comparatively successful in both Eastern Europe and the Levant, and their policy in Syria in particular has been quite successful. Because Obama decided not to pursue a military strategy in Syria, the United States is now practically out of the whole regional negotiations on the future of Syria.

On the trade side, the new tax plan could lead to a US deficit over the next ten years of USD 1.5 trillion. How to finance that? Because at the same time, Mr Trump wants the multilateral trade system changed to bilateral trade where each country does about the same amount of trade. The way that the Americans have been financing their massive budget deficit is through savers in Japan, China, South Korea and Germany. If you take that away, how do you finance this budget deficit, which is now USD 600 billion? The only other way to do it is a massive increase in the interest rates.

If Mr Trump pursues that policy over the next three years, it will not be good for the United States and its relations with the rest of the world, nor for the stability of the rest of the world, because we would go from a relatively stable if not perfect Pax Americana, to a completely unknown situation, that we have not seen in 70 years. All the issues that we have in the Middle East are in part related to this decline of the US, which makes it

possible for other powers to emerge and create a much more dangerous situation for the world.

There are several ways to approach the geopolitics of energy in the Middle East. First let's notice that many governments in the region, both in the Middle East and North Africa, are opening their assets to foreign investors, as well as trying to convince the big oil and gas companies, power and water companies to come back. It will be necessary to look at what sort of investment environment one should expect.

To understand MENA geopolitics and the root cause of some of the major problems today, we have to go further back into history, probably to the fall of the Ottoman Empire, to the Balfour Declaration etc. The Arab oil embargo (October 1973) was an extraordinary shock and we was carts, horses and bicycles occupying the streets in many European countries. The year 1974 led to the shift of oil pricing power in favour of OPEC. The embargo is still the back of the mind of many policymakers. Most of US Presidents say that their policy is really to end the dependency on OPEC oil.

Later, in 1979 we see the Iran revolution, and the subsequent Iran-Iraq war, with great upheavals. Then the 9/11 attack on New York and the consequent demise of Al Qaeda, which mutated and was probably the origin of Islamic State or Daesh. Also, the Arab Spring was a major event.

In the energy sphere, after the two oil price shocks of 1973 and 1979 there has been subsequent erosion of OPEC's market power and the resulting 1986 oil price collapse. The 2014 oil collapse has some similarities with the collapse of 1986, in the sense that it is the result of major structural transformation of the industry. It has also had a major impact on the oil producing countries.

Today's conflict of economic and strategic interests of the main powers, namely the US, Russia and probably also China, and the competition for influence in the region, particularly between Saudi Arabia and Iran, have increased the uncertainty of the outcome, whatever underlying analysis you make. It is extremely difficult to predict events that are rooted in such environment. There are questions, but really no answers:

- How long will the proxy wars in Syria and Yemen last?
- How will Daesh reorganise after the loss of Iraq and Syria?
- To what extent can the Iraq-Kurd standoff fuel further instability in Iraq?
- How deep are the crises over Qatar and the cracks appearing in the GCC?
- What further domestic pushback to Mohammad bin Salman's overhaul of Saudi Arabia, on the economic and social, but also the power struggle currently taking place?
- How will Iran react to the US negation of the nuclear deal and added sanctions?
- How long will Egypt's counter-revolutionary torments endure?
- Will the United Nation's special representative Ghassan Salamé's action plan help to resolve Libya's political turmoil?
- Will Algeria be able to cope with fraught domestic issues?
- Where will the Israeli-Palestine conflict lead?

Regarding investment climate, big political risk consultancies have moved from pure political and country risk to integrate the security aspect in this region. The security landscape for each country is colour coded from a light blue, which is low risk, to dark red which is extreme risk, as in Syria; part of Iraq, Afghanistan, Yemen, and Libya. This is accompanied by a letter designating the political risk with the same gradation of low, medium, high and extremely high. Saudi Arabia will probably have some red in the near future, and against that background it is really difficult for a company to be involved. Of course, the big oil companies have the capacity to mitigate such risks, but it comes at a cost.

Saudi Arabia and the UAE are probably the most attractive countries in terms of investment and the worst are Syria and Yemen. Despite the emerging threats, the Gulf countries together remain the most appealing region in terms of investment.

In conclusion, geopolitical tensions, violence, jihadism, but also oil price uncertainty, will exacerbate the risk perceived by global investors. Political violence in countries such as Iraq, Syria, Libya and Yemen, retains the potential of spilling over dangerously to their neighbours. We have already seen Yemen launching Scud missiles on Saudi Arabia from time to time, but it could become more fraught. The current rally in oil prices could reduce of the region's macroeconomic risks, but is will not ensure fiscal sustainability and the fiscal problems will be with us for some time. Finally, in countries with the largest potential, including Saudi Arabia, Iran, Iraq, and Algeria energy investment could still be secured with more favourable policies, institutions and investment climates.

Session 3: Current issues - Prices

Crude oil prices have recovered quite impressively over the last weeks and Brent has moved from a nine-month period of torpor at around USD 50 per barrel. Stability, or lack of volatility, is not something the trading companies particularly like as it signals a certain lack of opportunity out there in the market. Nonetheless, market has moved considerably higher in terms of the flat price. Throughout the 2014 to 2017 period, market registered strong demand. The price collapse has nothing to do with weak demand in the oil market. There was a modest stock draws and there has been a lot of positive chatter in the market about OPEC continuing to restrain production to the market and particularly in the last three weeks or so. We have had elevated political risk (in Kurdistan, what is happening in Riyadh and elsewhere).

Market structure is now, at least for Brent, in backwardation, so the incentive to build stocks is no longer there, and prices are encouraging an arbitrage of crude from Western to Eastern markets, with strong Dubai and Gulf prices and relatively weak WTI in US based prices. Price volatility is relatively, but low level of volatility may be transient.

It is worth revisiting the market got to USD 50 or below in the first place. Between 2014 and 2016, OPEC decided to compete head-on for market share with non-OPEC producers and US light tight oil in particular. In that period, supply was running ahead of demand and we accumulated globally anything up to a billion barrels of inventory. About half of that apparent accumulation of inventory, maybe 500 million barrels, actually occurred in the OECD (so far in 2017). Despite all the fanfare about stock draws, we have probably drawn anything between 80 million and 90 million barrels which is less than one fifth of what we accumulated over the period 2014 – 2016.

Some of the optimism in the market is perhaps a little bit premature because the convention in oil market analysis is to measure inventory against a rolling five-year average. As market moves forward in time and starts incorporating ever higher levels of stocks from the prior two years, it is not surprising that stocks look quite close to being rebalanced after having drawn 80 million or 90 million barrels. OPEC and other producers actually have rather more to do before they can really claim success in terms of rebalancing the market.

Demand growth was robust over the last three years, with 1.5 to 1.6 million barrels per day, a figure at the upper end of the historical trend, and such growth should continue depending on OPEC and Russia's ability to continue restraining production and cut their supplies to the market further.

It will also depend on what US suppliers do, because the advent of USD 50 oil, or a USD 50 floor for oil, which OPEC's agreement at the end of 2016 put in place, has provided US shale producers with an incentive to invest and drill again. In 2017, there was a fairly dramatic growth in US light tight oil supply, and such growth is expected to continue into 2018. There is a potential for total US liquids supply to grow by as much as one million barrels per day in 2018 (existing forecasts are between 800 000 barrels a day and one million). Not all of that is crude, arguably about half is gas liquids, but nonetheless there is a bump in non-OPEC supply likely in 2018 and 2019, which may make other producers' jobs rather more difficult.

Perhaps producers will have more to do. A perception is that the market could be over-supplied in 2018 by between half a million and a million barrels per day. Some imbalance

in 2018, 2019, can be removed by geopolitical elements, but one cannot really forecast with any certainty that those supplies will be removed from the market, but it will be worth watching.

On the demand side, demand growth is very broad-based and in fact, over the last three years European, US and other OECD demand has been growing. This year in particular, there was a major pick-up in industrial demand for oil in Europe and the US, and that means diesel has rebounded. A year ago, everyone had written-off diesel. Again, it is the temptation of those of us in metropolitan Europe to extrapolate our own experience and say we are all getting rid of diesel cars, therefore diesel is dead. It is not. Not only do the emerging markets rely on diesel, and are there will be more use of diesel for marine transportation in the short to medium-term, but even Europe and the US are burning more diesel in 2017 and probably beyond and over time.

What about the emerging markets? Everyone knows the story about China. China is transitioning industrially and is moving from being a 600,000 barrels a day a year growth market for oil, to one that is probably closer to 350,000 or 400,000 barrels per day of growth. Oil demand is still growing in China, though more slowly, and the composition of that growth has changed. It is much less about residual fuel oil and diesel for industrial purposes and more about LPG and naphtha and gasoline. The trade of gasoline components into China as well as crude oil demand into China has been very strong. The idea that China as a motor for oil demand growth is over as a story, is very wide of the mark.

India is the other obvious candidate we would look at. Over the last two years, Indian demand has grown by about 300 000 to 400 000 barrels a day. It is beginning to challenge China in terms of its primacy of the level of oil demand growth. The problem for India in 2017, in which demand growth has been fairly negligible overall, is that they have confronted a perfect storm of issues including monsoon impacts, demonetisation, tax changes, etc. They have also done something which is to close a loophole for the use of petroleum coke in the power generation market. A lot of the 2015, 2016 growth in Indian demand was actually petroleum coke, when they were substituting petroleum coke for coal in power generation. They have removed that loophole in a sense, and as a result Indian demand growth has diminished. Since India is investing in infrastructure and trying to beef-up its relatively undeveloped industrial base, one would probably be relatively buoyant about prospects for oil demand into India.

Regarding peak demand, we should never overlook the potential impact of disruptive technologies, and we know that electric vehicles will eat into transportation, one of key markets for oil demand. However, the upper end of the most optimistic expectations for electric vehicles, at least over the next 15 years or so, is some 200 to 300 million units. That equates to something between three and four million barrels per day of oil equivalent over 15 years, an amount that is not lead to peak oil demand, any time in the next 15 years.

One should also remember that there are improvements in internal combustion engine vehicles, which will probably be more effective in terms of decarbonisation, than electric vehicles. All is all, it is very difficult to see, just given the latent potential of emerging markets, that a peak in oil demand will occur any time between now and 2030.

Strong oil demand has meant strong refining margins and limited spare capacity in the refining sector as a whole. Over the last three years, it has been a mini-golden age for the oil downstream, really very much against expectations, at least for the European refining sector. This has occurred despite the fact that in less than 10 years, the US has gone from being a net importer of 3 million barrels per day of refined products, to a net exporter of 3 million barrels per day of refined products. There is a lot of talk about shale oil and it has been an amazingly impressive phenomenon. However, in terms of crude, the US is exporting about a million barrels per day and still importing about eight million barrels per day of crude. The major shift of six million barrels a day has happened in the refined products sector and that has been much more dramatic than what has happened in the upstream sector in terms of the US net trade position for liquid hydrocarbons.

Hurricanes Harvey and Irma were among the issues that emerged in 2017, after a decade of really not featuring in the market. That, notionally at least, should play a major role given a US Gulf role as the world's swing supplier of refined products. Some years ago, market analysts were much more preoccupied by the impact of hurricanes on the US Gulf crude production than on refined products supply, although even back in 2005 and 2008, refined products were becoming more important in that sense. It is clearly the case now, that it is the US refining system that risks suffering the greatest disruption from hurricane outages. However refiners on the US Gulf coast have essentially learned lessons from 2005 and 2008, and they are now much more resilient in dealing with potential flooding, etc.

Turning to US upstream, there is no doubt that US shale production is growing again. Today US supply is growing by 800,000 to 900,000 barrels per day year on year. The pace of growth may be a little bit slower going forward, something around half a million barrels per day for the medium-term.

A conclusion could be that once we get beyond over supply, which could persist in 2018 and 2019, we need higher prices to bring more investment. Shale plus short cycle non-OPEC investment, plus limited upstream capacity expansion in OPEC will certainly lead to higher prices beyond that horizon.

As far as demand is concerned, growth is running at almost 2 million barrels a day in 2015, 1.5 to 1.6 in 2016, 2017 and probably 1.5 in 2018. We are well off track today for the 2 °C scenario that the IEA has projected, and we are probably going to maintain a trajectory of one million barrels a day out to about 2025 at least. That correction is going to take time to come, and the 2 °C scenario is going to be harder and harder to attain. Climate change is going to happen and trajectory towards lower hydrocarbon use is inevitable, but it is probably not going to happen significantly beyond 2040.

Demand growth is robust; it is a function of GDP growth and price levels are still fairly modest despite the recovery this year. The trends remain reasonably strong to 2025. Around 100 million cars are sold each year, a growth that also reflects the economic drivers that have been fairly robust over the past year, but in the longer-term the emerging markets are really the place to watch as improving prosperity is helping to pick-up demand for mobility. Mobility is vital and as growth generates prosperity, prosperity generates demand for mobility.

Significant fuel efficiency gains in standard vehicles for a given size and power range were registered over the last five to 10 years, and that will continue to be the case. However, consumer preferences are for larger vehicles. In China, LDV sales have been dominated by SUVs, with 30% of sales in the last two years. Pushing towards improved fuel efficiency will in some respects require government agencies to say that they want consumers to have smaller vehicles, a very hard choice to make.

Despite electric vehicles, better efficiency, demand in 2040 will probably not be below where it is today. Demand in 2040 is probably going to be more than 100 million barrels a day, maybe close to 105 million. The underlying trends are very strong.

The mid-term risks on demand are very low. We should expect fairly strong demand growth between now and 2025. Beyond 2025, we will probably see a progressive plateauing and then, perhaps between 2035 and 2040, a tip into slower demand growth and into progressive decline in demand that will accelerate after 2040. That will depend on how fast we get into using electric vehicles. If you look over to 2040, even if you are selling 50% electric vehicles and have 500 million electric vehicles in total, there will be a very modest impact in terms of overall oil demand (around 8 million barrels a day). However, beyond 2040, that picks up fast and it is going to start displacing a lot of oil and that I think is where we have to stop flattering ourselves about the issue of peak oil. It is going to be a 2040, 2050 issue and not a 2030, 2040 issue.

On oil supply, the slow oil price recovery between 2016 and 2017 has not really made a big difference on upstream investment. It has revived a little bit of the investment, but we are still very far behind on upstream investment. As we have seen, there has been a

systematic downward correction in the DOE realised production in the US, versus the initial forecasts.

Looking at the 2022, 2025 horizon, one should expect growth in demand of about 6 million barrels a day, over a five-year period. The potential for decline rates is about 16 million barrels a day. That means that we have 22 million barrels a day to replace over that period. There is about 16 million barrels a day of projects under development right now, which gives us a notional supply gap that has to be filled of about 6 million barrels a day. To generate these 6 million barrels a day, we have to have a price in the USD 60 to USD 70 a barrel range at that point.

Regarding downstream, refiners are going to have to ramp up their runs intensively in order to meet a change in bunker specifications worldwide. That is going to be rather complicated. The spare refining capacity that we used to have over a long time is over. It ended in 2015 and we have had excellent refining margins since then. The spare refining capacity is down to as low as it was between 2003 and 2007, a period referred to as the golden age of refining. The spare refining capacity is not going to change in the near future, because there are really are very few incremental refining capacity projects in the works. Why? Because of the dominant perception of investors that investing in refining not required as we are heading toward a peak of demand. It is the same thing in India, where Prime Minister Modi is saying, in 2030 we do not want anymore gasoline or diesel fired cars, so the Indian refineries are saying they do not want to build anymore major projects. We are really hitting a period now where there is a slow-down in incremental refining capacity construction. Between now and at least 2020, if not 2025, there will be very little incremental capacity as well. It will be debottlenecking and any incremental measure you can imagine, to increase capacity, so that we can get the benefit of those margins.

As a result, on 1 January 2020, we will be hitting one of the biggest changes the refining industry has ever had with the reduction in bunker sulphur specifications, from roughly 3% worldwide to 0.5% sulphur. Accomplishing that is going to be a huge problem for refineries and there will be 30% of bunker users that are not going to comply. There will be few ship owners that will be using LNG, and few that will build scrubbers. In reality, there is probably going to be about 50% of that fuel oil that has to be replaced by gasoil. That means that some 1.5 million to 2 million barrels of gasoil have to be moved from the current uses into that pool. That means you will have to start taking molecules away from other applications, like cracker feeding and it just tightens up the whole barrel.

The growth in US shale is probably much lower than reported by the IEA and also most analysts. When you look at the actual PSM production releases, they are clearly on the trend of 30 000 to 40 000 barrels per day increase per month and certainly not the 100 000 or 120 000, that most people were expecting even a few months ago.

Why is this happening? The first reason is clearly the bottlenecks in the supply chain, so the price has destroyed most of the oilfield services industry and it has been easy to mobilise rigs, but very difficult to mobilise manpower so you see a big gap in the fracking activity, versus the drilling activity. As a consequence, there is a huge number of DUCs (drilled but not completed wells) which could be fracked, but which need the fracking fluid. This creates a real option for producers to put this capacity online.

Clearly there was a big story about technology and improving productivity, but the actual productivity of wells in Permian has plateaued since mid-2016. In terms of productivity, most people look at productivity in terms of production per rig, which means nothing, because if you have a lag in fracking after the drilling, it is an irrelevant number. The number published by the IEA does not mean much. What you have to look at is completion rate in well potential, which is initial production of a well. It has increased between 2014 and the beginning of 2016, and it has plateaued and decreased since mid-2016. The technology is clearly plateauing in the Permian.

We can look also at Delaware and Midland. When you look at the productivity in each of these two major counties, they have both increased but Delaware is still much more productive than Midland. If there has been sweet spotting, we should expect more wells in the Delaware than the Midland, and this is clearly what has happened since the crash. The

increase in productivity in Permian is not a technology driven event; it is a sweet spotting phenomenon.

Obviously, that leads to the potential of shale and whether it will go up to the kind of supply we will need, and the answer is probably not. What is more worrying is that we look at the water content of each well and it is increasing, even though the productivity is plateauing and again this normalises the completion rated. The fact that you need more and more water and sand and proppant for any barrel of production in the Permian goes against the conventional wisdom that technology is improving.