Energy trends

Interview with University of Texas Professor Scott W. Tinker, state geologist of Texas and Director of the Bureau of Economic Geology, on trends and challenges in the oil and gas industry

With hydrocarbons representing the majority of primary energy consumed, the continuity and reliability of their supply are of fundamental importance to all other parts of the economy. No wonder that the price of oil is followed, commented and analyzed like no other commodity. Besides its economic importance, there are many other reasons to be fascinated by the oil and gas industry. In this interview, Scott W. Tinker talks to *ABB Review* about the challenges, developments and future of the industry.

Prof Scott Tinker, thank you for joining us. Where do you see the major trends in the oil and gas industry?

There are several macro developments going on. I'll start with the industry structure. International oil companies (IOCs) have been merging and acquiring one-another for some time now. In parallel, what were once national oil companies are becoming international oil players. These companies are all seeking to increase their reserves through exploration and acquisitions.

Another macro trend is the transition from conventional to unconventional reserves. The unconventionals include heavy oils but also unconventional natural gas such as tight gas[1], shale gas, coalbed methane, methane hydrates and others.

What these trends and challenges have in common is that they are about access and reserves. The successful players of the future will be those that, through various means, have access to the largest reserves.

Another trend concerns what I call "above-ground" challenges. "Below-ground" challenges are about exploration and technology; above-ground are environmental, legal and regulatory. The industry must inform and educate people, be transparent, understand their concerns and dispel many myths that surround the industry.

Oil and gas account for more than half of global primary consumption and are thus fundamental to the economy. People are concerned about the volatility of energy prices.

If we look at the last eight global recessions, seven were preceded by a spike in the price of oil. Every one of the last four major recessions in the United States was preceded by a spike. I'm not saying that that correlation is causation; recessions are much more complex than that. But energy is a critical – even foundational – part of any economy. As oil is a proxy for energy (at least historically) its price is a strong signal.

What is it that makes oil and gas so irreplaceable?

Oil is a unique fuel – it's a miracle fuel – you can convert it into so many things,

Title picture
The Ormen Lange onshore gas processing plant in Norway, operated by Shell

Footnote

1 Tight gas is natural gas that is difficult to access because of the low permeability of the rock that surrounds it. Special treatments are required to extract it.

LNG tankers are making natural gas a physical global commodity. This is Gaz de France's tanker Provalys, equipped with an ABB propulsion system.

It is easier to create state-of-the-art systems from scratch than it is to retrofit old facilities to bring them up to the same standard.

the most important of which is gasoline or diesel. You put it into your gas tank, burn it, and it leaves no trace in the tank that you need to clean. It has a high energy density and it is safe. It is remarkably affordable. It is very difficult to replace oil and that is why the transport sector is dominated by it.

Natural gas is very versatile: It is used in power generation, for heating, and its use is also increasing in transportation. It is cleaner than coal or oil in terms of CO_2 emissions, but also in terms of SO_x, NO_x, mercury and other pollutants from coal. Its position in the energy mix is significant and set to grow further.

One significant difference between oil and natural gas is that natural gas is not yet a physical global commodity. We don't move it around as we move oil yet. The market is much more regional.

You say "yet" . . .

The development of facilities to both export and receive natural gas is progressing. As they grow, we will be able to move natural gas to places that don't have it, and be able to mitigate some of the volatility and deliverability of its supply. Natural gas is going to be a big part of the economy of this century.

Will LNG tankers do for gas what oil tankers did for oil?

Potentially, but LNG has been slowed a bit by the accelerated development of unconventional gas. Eventually, I think LNG will be quite important. I was in Qatar looking at the largest LNG facility in the world: an Exxon Mobil – Qatari government partnership called RasGas. They have seven trains finished and I think an eighth in progress – and these are large trains. There is a city of about 40,000 people there to build and maintain them. The installation moves about one LNG tanker a day, loading it with more than 140,000 tons in 12 hours. Such a ship is about 300 m long, 100 m wide and 10 stories tall. The propeller is about 10 m in diameter. It runs on either diesel or (not surprisingly) natural gas, depending on the Btu price, and can do over 20 knots. They have a fleet of more than 50 such tankers!

An oil tanker is not too dissimilar. Of course it doesn't need to be cooled. A water "curtain" runs down the side of an LNG tanker while it is being loaded because if LNG hits the hull of the ship, it can crack. A typical oil tanker may have 500,000 to 750,000 barrels of oil on it. It runs largely on diesel. In both cases, it takes a lot of energy to move but there is an awful lot of energy on the ship.

So the technology for moving LNG efficiently is already here. It is now a question of adding capacity?

Yes, the facilities are large, expensive and require permitting. People are a little worried about them and there is some misunderstanding about the safety of LNG tankers. Although it hasn't been tested yet – and I hope it never will – simulations show that even if you put a torpedo through the dual hull, the LNG would basically "flow" out, change its state and burn. That would generate a lot of heat and wouldn't be good for the immediate vicinity but the tanker wouldn't really explode like a bomb. The event would basically be self-cleaning. In some sense it would be preferable to an oil spill, which is much more difficult to contain and clean. But having said that, you still wouldn't want such an incident to occur in a port close to communities and infrastructure. Offshore facilities will allow docking some tens of kilometers out at sea and a pipeline will bring in the gas.

What are the technological challenges in extracting oil and gas?

The main challenge is getting at the molecules. It has often been said that the easy oil has already been found. It wasn't always that easy to find the oil, but it was easy to produce once we found it – it came out of high-permeability rocks. Today we have far better engineering and better understanding of geology but the exploration environment is more difficult. For example, we are drilling in water depths over 8,000 feet (2,500 m) and working in the arctic or in the oil sands of Canada. These regions are not just more challenging geographically, but also technologically. And thus they are expensive.

Let us look at shale gas for example. Natural gas exists across the vast geographical extent of the shale basin. Basin's are heterogeneous and rock-fluid conditions will vary. Every basin is different. Companies have to be intelligent about where they drill and how they access reserves from a surface disruption (environmental) perspective. Instead of having a well every ten acres, multiple long-reach laterals are being drilled from a single surface location.

Water is another challenge. The operation has to access the formation, produce methane and water, separate the methane and re-inject the water. A tremendous amount of fresh water goes into hydraulic fracturing, and things like proppants have to be put into the water to hold the fractures open. Formation waters are produced, and either need to be cleaned up at the surface or re-injected; both of which cost money.

Many older fields have been producing for decades and are now in decline. What can be done to prolong their economic lives?

Many older oil fields are indeed in decline. But often the production tails are longer than we thought as we are finder better ways to coax that next barrel out. However, despite the best technology, we are still leaving a lot of oil behind. If you spill oil on your shirt or the garage floor, you see how tough it is to get out. Rocks are like that as well. Depending on the field the amount left in the ground can be less than half, 60 percent or even 80 percent or more.

Methods used to extract additional oil include water flooding, and chemical, thermal and even microbial processes. These are all costly. We often know we can make more oil but if we can't recover the costs then we don't do it. Energy is a strongly cost-driven sector and if you don't know if the oil price next year will be $150 or $50, it is difficult to convince your stockholders to support such an investment.

Non-OECD countries such as China and India are seeing unprecedented economic growth. What effect is this having on oil and gas?

There are 600 million people in India that don't have access to modern energy. That is almost twice the population of the United States. China has a similar number. That's not considering the combined billion people in those countries that already have access to energy; and this number is growing rapidly. In 2005, the number of automobiles sold in China was about a third that of the United States. Six years on, China has already surpassed the US figure and is approaching 20 million cars a year. This growth is going to continue – and rightly so. There is a clear correlation between access to energy and economic health.

The challenge is to not industrialize in the same way that the OECD countries did the last century. We industrialized in the best way that we could, given the technology of the time. But that was an experience that cannot be repeated. Trying to repeat that would stretch the energy supply enormously while impacting the economy and the environment. Non-OECD and OECD countries must work together to deploy energy-efficient, economically-efficient and environmentally sound technologies. Many of these technologies are already available. The great opportunity is that it is easier to create state-of-the-art systems from scratch than it is to retrofit old facilities to bring them up to the same standard.

What is the potential for energy efficiency?

Energy efficiency is certainly the low-hanging fruit if not the fruit on the ground. The United States consumes about 100 quads (or 100 EJ, or 100 TCF of natural gas equivalent) of energy per year. Less that half of that, so about 45 quads, is turned into useful energy. Most of the rest ends up as wasted heat, be it heat from industrial stacks, from commercial buildings, tailpipes or heat lost in homes. Increasing energy efficiency is about reducing the energy lost as heat. Again, this is easier to do in new builds than to retrofit. As an example, in my own home I put in new fluorescent bulbs, improved the insulation and sealing of the structure, put in an energy-efficient water heater and other such measures. The sad truth is that the investment will never pay back economically. It is good to save energy, but it is more philosophical; we feel good about it. Had we implemented those features from the beginning and actually built the house with them, I think they would have paid for themselves.

> One significant difference between oil and natural gas is that natural gas is really not a physical global commodity yet. We don't move it around as we move oil.

Energy decisions are mostly based on price. We see this in industry and also in personal choices. For energy efficiency to become more attractive it has got to become economically attractive.

How can that be achieved?

Companies can develop products that are designed to be more efficient and affordable. Individuals can play a part through their personal choices. Economies of scale will kick in. Governments can also make energy efficiency more attractive.

To what extent should governments get involved?

They can lead through broad incentives that encourage industries and individuals to become more efficient. But they should avoid the temptation of picking winners. One of many negative examples here in the United States is corn ethanol. Corn ethanol is not energy policy, it is agricultural policy. It needs water and fertilizer and soil and is in competition with food production while its net energy balance is pretty low. It would have been better for government to create broad goals (emissions, efficiency, low energy, low cost, whatever . . .) and allow industry, academia and others to compete in developing the best solutions. Take CO_2 emissions. If coal or natural gas can meet targets and be as affordable as wind, solar and others, then we should allow for that. But there are often other

Statoil's LNG plant on the Norwegian island of Melkoya (part of the Snovhit gas field). ABB delivered a range of power and automation products to the plant.

Technology and price are inextricably linked. When the price is right, a technology becomes viable.

interests driving policy that go beyond the stated goals. That is when governments get in trouble

Talking about CO_2, what part can carbon capture and sequestration (CCS) play?

The Bureau of Economic Geology, where I work, is one of the leading carbon sequestration research groups in the United States. We were the first to put over a million tons into the Earth. It is fascinating science and technology.

Looking at the bigger picture, I think we should be asking three framing questions: is it possible, is it doable and is it sensible?

Is it possible? In the Bureau we are looking at the geology and studying how we can put it into the Earth at volume and rate. Others are studying how to capture CO_2 from stacks. As research progresses the answer looks more and more like it is possible in some areas, driven largely by geology.

Is it doable? Can it be accomplished in terms of policy and regulation? Will people accept carbon being sequestrated under their back yard? This is more of an aboveground challenge. Again, I think it could be doable, but there is a lot of work to be done, and it won't be doable everywhere. And finally, is it sensible? What is it going to cost and what will the environmental benefit be? The world currently produces between 25 and 30 Gt (gigatons, billions of tons) of CO_2 annually from anthropogenic sources. To capture 1 Gt annually we would have to realize 1,000 projects of one megaton (million tons) annual injection each. A megaton project is a big project. We have to find suitable locations and to be able to afford to do them. The capture part is expensive (billons of dollars per major facility). The compression and injection part is less expensive, but there is still a lot of money involved. Add to that the regulatory and legal aspects and the overall costs are going to be very high, adding substantially to the kWh price of power from coal. And will it make a difference in terms of climate change? The infrastructure will take time to ramp up. And this total of 1 Gt/y, ambitious as it may seem, represents only about one thirtieth of total emissions. Huge challenges are involved in being able to accomplish that at the pace required. And all the time while we're doing this research, the clock is ticking. Although most who are invested in CCS or climate research won't say it, I worry if CCS is sensible. Time will tell.

CO_2 is not the only environmental issue surrounding the oil and gas industry. Another area of concern is hydraulic fracturing.

The process of hydraulic fracturing has been going on for many decades. It has also been used in conventional drilling. When the liquid is contained in very small pores (tight rocks), the only way to get at it is to induce the rock to crack so that the liquid can flow. These cracks are kept open by introducing proppants. This typically happens between 3,000 and 10,000 feet (1,000 and 3,000 meters) below the surface of the earth. The energy used in the hydraulic fracturing process presents a natural limit to how far from the wellbore fractures can extend.. We have done close to one million frac stages in the United States. Some well bores have over 30 different frac stages along the horizontal well path. The fracturing itself has, to my knowledge, never created fissures that went all the way to the surface. It would require a far more powerful process to do that and some laws of physics would have to bend a bit . . .

That said, the process of drilling wells and of moving fracturing fluids in by truck and handling them on the surface is associated with a certain risk. Leaks and spills can occur, as they can in any other industry. We should work to improve those processes: The target should be zero spills. But we usually know when a leak has occurred. The damage tends to be locally constrained and the leakage can be stopped and damage contained and mitigated. Such an incident is bad, but it's not going to contaminate a very large geographic region.

What other tendencies are going on in unconventionals?

Technology and price are inextricably linked. When the price is right, a technology becomes viable. One area with a lot of potential is the Arctic: Very little of the basin's vast oil reserves have been extracted. We are going to have to work there in a way that is environmentally sound.

The same is true of the oil sands in Alberta, for example. Oil sands have been mined at the surface. That's a not a particularly environmentally friendly thing to do – in fact it's quite ugly. But technology has progressed and now we're seeing what is called steam-assisted gravity drainage (SAGD) in which water is boiled, using natural gas, to make steam. The steam is sent down into well bores to heat the oil (which has about the density of a hockey puck) and liquefy it. The surface impact of this is minimal. When finished, the well head is moved and once the trees have grown back there will be few signs that anything happened there.

These SAGD operations are expensive, but with demand for liquid hydrocarbons still strong, and with the price of hydrocarbons continuing to rise and technology also progressing, more and more reserves will become viable. Some people say (and have said for decades) that oil and gas production is peaking: They are thinking in today's economic and technology paradigm. Supply will eventually peak, especially as we stop exploring and moving into new areas (geographically and geologically). As fossil energy prices rise, other energy sources will become more viable and gradually replace oil and gas. One day we may look back and ask, "why did we ever burn oil in our cars?!"

So if oil peaks it's not going to be because we are running out, because we have found something else?

Something else more affordable, or even better! There is a silly saying that the Stone Age didn't end for lack of stones. And the oil age will not end for lack of oil. At the right price, there remains a tremendous global oil resource. Consider that there was a time that we used whale oil for lighting. I may get hate mail for saying this, but because petroleum came along, we no longer needed to hunt whales for oil. In a perverse way, oil saved the whales.

How many hydrocarbons are still out there?

The world has consumed just over a trillion barrels of oil, and about 1,000 TCF (trillion cubic feet) of natural gas. There are anywhere from five to 10 trillion barrels of oil remaining and probably 5,000 to 10,000 TCF or more of natural gas – at the right price. The challenge is that you cannot get to most of that economically. As the oil price continues to climb – and we can argue whether or not the present development is a spike that will come back down, it probably is – but it may be a price point now that sustains opening up quite a bit of those expensive to reach oil molecules.

Scott Tinker

Scott W. Tinker is Director of the Bureau of Economic Geology, the State Geologist of Texas, Director of the Advanced Energy Consortium, a Professor holding the Allday Endowed Chair and acting Associate Dean of Research in the Jackson School of Geosciences at the University of Texas at Austin. Scott spent 17 years in the oil and gas industry prior to coming to UT in 2000. Scott is past President of the American Association of Petroleum Geologists (2008–2009) and the Association of American State Geologists (2006–2007). Tinker was a Distinguished Lecturer for the AAPG (1997), Society of Petroleum Engineers (2002), and Distinguished Ethics Lecturer for the AAPG (2006–2007) and won best paper awards in two major journals. Tinker holds appointments on the National Petroleum Council, the Interstate Oil and Gas Compact Commission and serves on several private, professional, and academic boards. Tinker's passion is building bridges between academia, industry and government and he has given over 400 invited and keynote lectures and visited over 45 countries towards this end. Tinker's degrees are from the University of Colorado (Ph.D.), the University of Michigan (MS), and Trinity University (BS).

Hydrocarbons are not just a source of energy. What about the other uses?

With energy types such as solar, wind, geothermal and biofuels expanding, we will eventually see fewer hydrocarbons being burnt for energy. This means that more will be available for other valuable uses such as plastics, lubricants, and fertilizers. Hydrocarbons are truly amazing, and very difficult to replace.

Thank you for this interview

The interview was conducted by Andreas Moglestue of *ABB Review*:
andreas.moglestue@ch.abb.com.