Floating LNG
A natural gas innovation

China University of Petroleum
Beijing

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Matthias Bichsel became Projects & Technology Director on July 1, 2009. In this capacity, he is responsible for Shell’s contracting and procurement as well as technology development and deployment. In addition, he has oversees Shell’s safety and environmental performance.

He joined Shell in 1980 after obtaining a doctorate in geology from the University of Basel, Switzerland.

Matthias has worked for Shell companies and affiliates in Bangladesh, Oman, Canada, Indonesia, the USA and the Netherlands. In 1995, he became director of Petroleum Development Oman, looking after exploration and deep oil-field developments. In 1999, he transferred to Houston as managing director of Shell Deepwater Services. There, he was involved in all aspects of deepwater exploration and development on a global scale. From 2002 to 2006, he was Executive Vice President in charge of global exploration. And from 2006 until his current appointment, he was Executive Vice President - Technical for Shell Exploration and Production.

He is a member of the American Association of Petroleum Geologists and the Society of Petroleum Engineers, where he is Member of the Industry Advisory Council. In 2011, he was appointed an honorary professor at the Chinese University of Petroleum, Beijing.

A Swiss citizen, Matthias was born in 1954. He is married to Suzanne, and they have a daughter.
China has clear priorities with respect to energy: secure it and use it efficiently while protecting the environment. Shell sees plenty of opportunities for mutually beneficial partnerships in pursuit of those national goals. The development of natural-gas resources offers a particularly promising opportunity. Natural gas is accessible, affordable and has the most acceptable environmental footprint of all fossil fuels. And Shell is a recognised leader in gas-field development and gas-liquefaction projects. The latest embodiment of Shell’s engineering prowess is the world’s first facility to produce, liquefy, store and transfer liquefied natural gas at sea. It has the potential to revolutionise the industry.

Hello everyone. I’m glad to be back at China University of Petroleum.

It’s been about a year since I accepted my honorary professorship here. A lot has happened in that time.

My main purpose today is to update you on some important developments that have taken place in the world of natural gas; and to give you some deeper insights into a revolutionary new technology that I touched on last time: Floating LNG.

Shell in China
Before I do that, let me remind you briefly about why Shell is in China.

We are here to provide energy solutions, and to contribute to the country’s three key energy priorities: security of energy supply, environmental protection, and energy efficiency.

In terms of market position relative to other international energy companies, we are the leading lubricants manufacturer and marketer, and number one bitumen supplier, with 12 bitumen production bases in China supplying high quality products to customers all over the country.

We are also the number one supplier of coal gasification technologies. Shell has so far provided proprietary coal gasification technology in China through 19 licenses. The technology helps China use coal in a cleaner manner.

All of Shell’s businesses are active in China: Upstream, Downstream, and Projects & Technology.

Innovation is central to all of these businesses. And many of the areas where we innovate are represented in China: for instance, petrochemicals and differentiated oil products; also liquefied natural gas, or LNG, as well as tight gas, shale gas and coalbed methane – I’ll be talking more about these a little later.

Shell’s four strategic priorities for growth in China remain the same. We’re focused on international cooperation with our Chinese partners overseas, to bring energy back to China. Secondly, we’re dedicated to developing China’s gas resources and providing quality, cleaner products to help meet the country’s energy needs. Our third priority is to take Chinese enterprises overseas. And finally, we are concentrating on R&D and technology cooperation, with prestigious institutions like this one.

Shell has a proud tradition of collaborating with leading universities and research institutes across the globe. Here in China, we are working with the Chinese Academy of Sciences and a number of top universities in a wide range of open-innovation and joint R&D activities. Some of those activities span the oil and gas industry – from upstream to downstream. And some of them look beyond oil and gas – and far into the future.

Among these collaborative activities, I am particularly pleased to see our increased R&D cooperation with China University of Petroleum. We are jointly developing new
chemical technology for enhanced oil recovery and novel catalysts for refining. And just today we signed a new agreement for a joint R&D programme covering unconventional gas exploration and development, to help meet China’s future energy demand.

Shell history in gas
I said I was going to talk with you today about natural gas. That’s an area that has seen amazing innovation!

When I started in exploration, some 30 years ago, people viewed finding gas as poor performance. All the attention was on oil. We had lots of technology to help us differentiate oil from gas pre-drilling, to ensure that valuable exploration funds were not wasted on gas. How times have changed!

We have moved from our industry flaring off natural gas as a waste by-product, to gas becoming a core part of the energy mix. In 2011, 48% of Shell’s production was natural gas. This year, 2012, we expect to produce more gas than oil.

Natural gas is not just abundant. It is also a hotbed of innovation. Just think about GTL and LNG, for instance.

LNG is what you get when you cool natural gas to -162 degrees Celsius. Shell’s track record in LNG goes back over 45 years. We helped to design and build the world’s first commercial onshore LNG plant in 1964.

Today, we are widely recognised across the industry as a technology and market leader. We’re involved in every stage of the value chain, from upstream – i.e. finding and extracting the gas – through processing, to distribution and sales. Shell is one of the largest LNG vessel operators in the world: around one-quarter of all the world’s LNG carriers are linked to Shell and our joint venture partners.

Gas today
Why do we concentrate so much on natural gas? Because of its ‘Triple A’ status as fuel. It is accessible, affordable, and has the most acceptable environmental footprint of all the fossil fuels.

Some people have described natural gas as a ‘transition’ fuel, part of the ‘bridge’ to a renewables-only future. However, the reality is quite different. All the energy forms we can deploy will be needed to meet global needs over the next few decades: not just wind, solar, biomass, hydro and the like, but also fossil fuels. Gas, especially, will be centre stage – it is not a transition fuel but a ‘destination’ fuel.

Over the last few years, this position has been reinforced by extraordinary volumes of gas found in the form of tight and shale gas, and coalbed methane or CBM. It is estimated that the world has enough recoverable gas resources for about 250 years at current production levels; and tight and shale gas and CBM account for about half those resources.

The US Energy Information Administration said last year that China’s shale formations may hold 12 times its conventional gas deposits. Last month, the nation’s Ministry of Land and Resources announced preliminary surveys showing exploorable shale gas reserves of 25.1 trillion cubic metres, enough – in theory – to meet China’s gas needs for the next two centuries.

China has been very dynamic in grasping this opportunity.

Together CNPC and Shell operate the Changbei tight gas field in the Ordos basin, where commercial production started in March 2007. In 2010 our two companies signed a 30 year agreement to develop tight gas in Jinqiu.

CNPC started shale gas exploration and development in 2006; it was the first Chinese company to do so. Last month Shell and CNPC signed a contract for shale gas exploration, development and production on
the Fushun-Yongchuan block in Sichuan basin.

I would also highlight the joint purchase of Australian coalbed methane company Arrow Energy, by PetroChina and Shell, in 2010. Our two companies are jointly developing the North Shilou CBM block; the project is currently in the appraisal phase.

You can see there is a lot going on. And Shell is able to bring to these ventures the benefits of our extensive experience in North America – not just in terms of finding and extracting tight and shale gas resources, but also in terms of the performance breakthroughs that we have achieved, and the reduction we have been able to make in our operations’ environmental footprint, through automation and other means.

Moreover, in China, we have been able to speed up the learning curve to reduce drilling time, compared with how quickly we achieved this in the US. It’s a winning combination: the great people we’re working with in China, and the power of bringing together their local knowledge with our international expertise.

In another joint venture with CNPC, we’re creating something very exciting for the future of tight and shale gas development.

I should explain that economically developing such fields requires hundreds, and even thousands, of wells. Normally, wells are drilled using rigs that are very large, complex, and multi-functional; and a trained crew drills each well individually.

CNPC and Shell have come up with quite a different model. In our concept, a group of smaller rigs, mounted on trucks, are employed. Each of these rigs performs a step, or a series of steps, in the drilling process, and then moves on to the next well. So, for example, one rig would drill the top part of the hole; another would drill the intermediate part of the well; and a third would do the completion work.

The rigs would be controlled autonomously, rather than operated manually. Several wells, at different stages of drilling and completion, would be being drilled in a given field at any one time.

We call this approach ‘well manufacturing’, because of the way it resembles a production line in a factory. It delivers what tight and shale gas, and CBM, require: a great many wells drilled quickly, safely, at reasonable cost, and with a smaller environmental footprint.

The well manufacturing concept is based on standardised well designs and automated field development. Shell has developed computer algorithms to optimise the drilling procedures and allow them to be automated. These have already been tested successfully in a heavy oil field in Canada, and are used commercially in gas wells in the Netherlands and the USA.

But it’s not just about automating the rigs. CNPC and Shell are looking at automating other functions as well: for instance, developing a system that could monitor drilling fluids real time and decide when to treat them.

Next game-changer: Floating LNG

All these efforts will underpin China’s future ability to meet energy demand. In the meantime, the pace of economic growth here has led China to become a net importer of energy. Domestic consumption of natural gas has exceeded production since 2009. Today, Shell is the largest LNG supplier to China in terms of contract volume.

And that helps to explain why the development of Floating LNG is so relevant here. This is a game-changing technology breakthrough. We believe it will revolutionise the natural gas sector.

In it, you can see the coming together of Shell’s technology leadership drawing on more than five decades of expertise in LNG technology, LNG shipping and operating offshore oil and gas installations.

“It’s a winning combination: the great people we’re working with in China, and the power of bringing together their local knowledge with our international expertise.”
For example, the first ever Floating Production, Storage and Offloading vessel, or FPSO, went into operation in 1977 for Shell, in Spain. Since then we have accumulated a wealth of experience and expertise with these floating solutions, which are essential to our industry’s offshore business activities.

We are now combining decades of revolutionary and incremental development in engineering and technology to create Floating LNG. Proven technologies are being brought together in innovative combinations, to realise an integrated concept, which is replicable elsewhere.

FLNG will allow Shell to produce, liquefy, store and transfer LNG at sea, opening up new business opportunities for countries looking to develop their gas resources and bring more natural gas to market.

Let me describe the vessel to you. Its length is nearly equal to five football pitches, and will have the displacement of six aircraft carriers. It needs to be this large to make the economics of its operation work, and also to help it withstand the often extreme weather conditions that it’s likely to experience.

The design is very clever. So, although the vessel is very large by maritime standards, it is still only one-quarter the size of an equivalent facility on land.

Top of our priority list, as ever, is safety – at every stage of the project.

The choices made during the design phase were based on over 10 years of studies of what would be required to maximise safety. So, for instance, the facility is designed to withstand a Category 5 cyclone. Extensive testing and simulation have been carried out, to ensure the vessel will stay moored in any weather conditions.

The storage facilities and process equipment are located as far from crew accommodation as possible. And procedures and systems are in place for operating in severe weather: they cover things like discontinued offloading, stopping production, and evacuating personnel.

I am also very pleased to note that the Shell Life-Saving Rules, which are mandatory in all our own operations, have also been adopted throughout the construction yard.

Another challenge that FLNG presents is sloshing. There is the potential for sizeable waves to develop within the LNG tanks when they are partly filled. These waves could be initiated under certain wave and weather conditions when using unfavorable tank dimensions.

To deal with this challenge, the tank dimensions are chosen so that sloshing is not likely in expected weather conditions. In addition, the tank walls are reinforced and – in extreme conditions - it is possible to optimise the inventory so that tanks are either almost full or almost empty, both helping to prevent damage. You have to bear in mind that the vessel is not planned to have drydock respite for 25 years.

Our FLNG design can provide high production rates: up to 6 million tonnes a year of liquids including LNG, LPG and condensate. Note, too, that it is multipurpose: the vessel can export Liquefied Petroleum Gas as well as LNG at the sides of the vessel; and condensate at the rear.

I’d like to shine a light on some of the clever ideas we’ve included. For instance, the vessel takes advantage of the fact that it is sitting in cold oceans and it takes cooling water from a depth of about 150 metres which helps to improve the energy efficiency of the liquefaction process.

We’ve chosen steam to drive the power generation, the compressors, and to provide reboiler heat.

I should also highlight an important process involved in the liquefaction: Shell’s proprietary Dual Mixed Refrigerant process, or DMR. This has two mixed refrigerant cycles and makes the process very flexible.
It is also better able to cope with changes in feed gas composition. DMR has proved to be very stable and efficient in the Sakhalin II project in Russia. It will add considerably to the FLNG solution.

FLNG is ideally suited to fields with reserves of 2-3 tcf and more, with high production rates and a range of gas compositions. Compared with other options, it has many advantages. FLNG is not only good for situations where you have stranded gas remote from shore. It has great potential close to shore, where you need to tie together several small fields. We also believe that FLNG will enable the development of larger fields via multiple facilities.

I said it looks like revolutionising the natural gas sector. That’s because of the unprecedented combination of benefits it offers: cost savings, less environmental impact, and increased opportunities to monetise natural gas resources in more challenging reservoirs and locations.

I am very excited about FLNG because it is good for operators, partners, customers and governments. It has the potential for faster, cheaper, more flexible development and deployment strategies for resources that were previously uneconomic.

I also like the way the vessel is part of an integrated approach. A successful FLNG project is much more than the facility itself. It includes upstream infrastructure and operations; product carrier management; LNG marketing; plus logistical and land-based support.

The technologies combined in FLNG are very impressive. But it’s not just about technical credibility. To succeed, an FLNG project demands: a proven capability to successfully deliver megaprojects; a balance sheet capable of supporting the finance and insurance requirements; the capacity to underwrite long term off-take and bring gas to markets; strong partnerships; and healthy project economics.

First application: Prelude project, Australia
I am glad to say, these are in place. And Shell is the first company in the world to get an FLNG project under construction.

This project, known as Prelude FLNG, has some impressive statistics. It is located more than 200 kilometres off the North West coast of Australia. 600 engineers worked on the design options. 175 Olympic-sized swimming pools would be needed to hold the same amount of liquid as the vessel’s storage tanks.

The facility is designed to stay safe and stable even in most extreme weather conditions. It achieves this due partly to its size, and partly due to being moored using one of the largest systems in the world: a turret 105 metres high, with 4 groups of mooring lines anchoring it to sea bed. This arrangement means the facility can turn slowly in the wind while staying moored over the gas field. And that means it will save valuable production days that would otherwise be lost to bad weather.

There will be three thrusters to enable some correction on the natural orientation of the FLNG facility in the prevailing met ocean conditions, which may assist with the mooring of LNG carriers alongside. Each thruster will have 6,700 horsepower – more than 10 times the power of a top-end performance car. In the vessel alone, 260,000 tonnes of steel are required. This is about 5 times the amount of steel in the Sydney Harbour Bridge.

The Prelude vessel’s LNG production could meet one and a bit times Hong Kong’s annual natural gas demand (117%).

Right now, preparations are being made for the vessel’s construction to begin in South Korea. Meanwhile, in Australia, we are working with local training companies, who have begun the process of training for operators of the facility. I don’t think it is an exaggeration to say that FLNG is opening the way to a new era in gas, with benefits for everyone: resource holders, customers, and other stakeholders. It is doing this using
proven technologies, in innovative combinations, based on an integrated concept, which is replicable elsewhere.

FLNG demonstrates how innovation is giving Shell and our partners a competitive advantage.

Training tomorrow’s scientists and engineers
It is also not the only such megaproject. Shell has introduced novel technology in large projects involving deep-water oil fields and enhanced oil recovery – both of which could also be relevant in China’s energy scene. If I had the time, I would love to describe them to you. For now, let me just emphasise the common features across all of them: they are mutually beneficial partnerships, with open innovation, and sharing of R&D strengths.

For that reason, I am particularly proud of our partnerships with Chinese universities and academic institutions. To develop and apply new technologies and help supply the world with sustainable energy, we will continue to need scientists and engineers. And Shell is helping to widen the talent pipeline in China through education.

I’m very pleased that Shell has set up a PhD scholarship programme in petroleum geosciences with the China University of Petroleum. We see this university as an eminent training ground for professional scientists, technologists and engineers – and also a fertile breeding ground for innovation. I am pleased to note that it is one of Shell China’s key campuses for graduate recruiting.

Conclusion
Currently, Shell is involved in many joint ventures in China. With our Chinese partners, we’re working on shale gas, coalbed methane, petrochemicals and other things.

But wouldn’t you all agree that there is plenty potential here in China – and elsewhere throughout the world – for even more partnerships, more innovation, more mutual benefit?

And that’s the question I would like to leave you with. I hope it will prompt some interesting thoughts and discussions.

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