



World Petroleum Council

YEARBOOK 2015

Leading *the* Industry



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challenge is our energy



World Petroleum Council

YEARBOOK 2015

Leading *the* Industry

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in conjunction with the World Petroleum Council (WPC).

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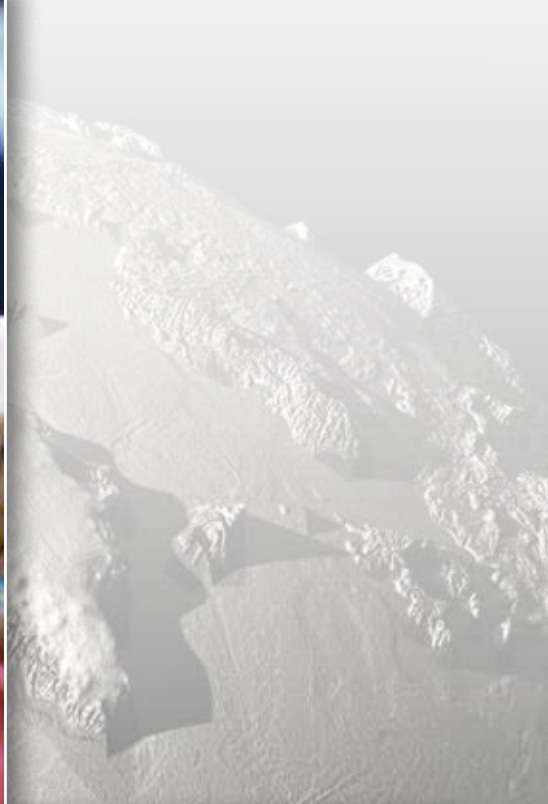
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Contents

Welcome to the WPC Yearbook 2015 – The road ahead for the WPC <i>By Dr Pierce Riemer, Director General, World Petroleum Council</i>	6	Agency and Chairman of the Spanish National Committee of the World Petroleum Council		US unconventional energy development and the use of industry standards <i>By J. Gerardo Uriá, Director of Membership and Global Industry Services, American Petroleum Institute</i>	98
Leadership Perspectives		Bank financing in a low oil price environment <i>By Peter Gaw, Managing Director of Oil, Gas and Chemicals, Standard Chartered Bank</i>	56	FLNG - F is for floating and flexibility <i>By Mark Blacklock, Editor-in-Chief, Inter- national Systems and Communications Ltd</i>	102
Leadership perspectives <i>By József Toth, WPC President</i>	10	Outlook on offshore oil and gas in the Arctic <i>By Jon Marsh Duesund, Senior Project Manager, Rystad Energy</i>	60	FLNG – A game changer for the industry <i>By Datuk Abdullah Karim, Vice President for LNG Projects, Petronas</i>	107
The oil industry as an innovator and leader <i>By Rex W. Tillerson, Chairman and CEO, Exxon Mobil Corporation</i>	14	The rise and rise of LNG in Latin America and the Caribbean <i>By Jorge Ciacciarelli, Executive Secretary, Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean</i>	64	Responsible Operations	
The energy industry's role in meeting supply and environmental challenges <i>By Ben van Beurden, CEO, Royal Dutch Shell</i>	18	Petroleum development and future opportunities in East Africa <i>By Wanjiku Manyara, General Manager, Petroleum Institute of East Africa</i>	68	Unlocking energy efficiency: A win-win strategy <i>Amin H. Nasser, Acting President and CEO, Saudi Aramco</i>	111
Setting a sustainable growth agenda <i>By Eldar Sætre, CEO, Statoil</i>	22	The bright future of India's petroleum industry <i>By Georgia Lewis, Managing Editor, International Systems and Communications Ltd</i>	72	Leading the industry on climate change <i>By Brian Sullivan, Executive Director, IPIECA</i>	116
Energy trends in a world of growing demand <i>By Spencer Dale, Chief Economist, BP</i>	24	Overview of the Russian oil industry: Challenges and prospects <i>By Ekaterina Grushevenko, Research Associate, and Dmitry Grushevenko and Anna Galkina, Researchers, Energy Research Institute of the Russian Academy of Sciences</i>	76	Taking the chill out of Arctic operations <i>By Liv Hovem, Director for Europe and Southern Africa, DNV GL – Oil & Gas</i>	120
The challenge to achieve sustainable energy for all <i>By UN Under-Secretary-General Dr Kandeh K. Yumkella, Special Representative of the UN Secretary-General for Sustainable Energy for All and CEO, SE4All</i>	28	Industry Innovation		A case study for sustainable development in Peru <i>By Ambassador Jeanne L. Phillips, Senior Vice President, Corporate Affairs and International Relations, Hunt Consolidated, Inc. and President, Hunt Global Partnerships</i>	124
Case study: Solutions to improve access to energy <i>By Jean-Marc Fontaine, Vice President of Sustainable Development, Total</i>	32	Engineering progress and possibilities <i>By John S. Watson, Chairman and CEO, Chevron</i>	82	A Turkish perspective on unconventional gas <i>By James D. McFarland, CEO, Valeura Energy and Member of the WPC Congress Programme Committee</i>	128
Global Cooperation		The WPC Youth Survey 2014 <i>By Katharina Gruenberg, Economist, Shell Global Solutions and WPC Youth Representative for the UK, and Csaba Zsótér, Head of Feedstock Supply and Trade for MOL Group and WPC Youth Representative for Hungary</i>	86	Managing change and maintaining deepwater safety <i>By Brian Salerno, Director, Bureau of Safety and Environmental Enforcement</i>	132
Challenges facing the oil and gas industry in the coming decades <i>By Patrick Pouyanné, CEO, Total</i>	36	Future prospects for Angola's oil and gas production <i>By Tako Koning, P.Geol, Senior Petroleum Geologist and Business Development Manager, Gaffney, Cline & Associates</i>	90	The evolution of the Operations Excellence Management System <i>By Brett Doherty, Chief Safety, Health, Environment and Quality Officer, RasGas</i>	136
Sustainably energising the world <i>By Abdalla Salem El-Badri, Secretary General, Organisation of the Petroleum Exporting Countries</i>	40	The role of the European refining industry in developing clean fuels <i>By Chris Beddoes, former Director General, Fuels Europe</i>	94	Committed to safety and the environment <i>By Jaime Martín Juez, Director of Safety and Environment, Repsol</i>	141
Security of supply and meeting demand on a global level <i>By Maria van der Hoeven, Executive Director, International Energy Agency</i>	44			WPC Vision, Mission and Values	144
Energy for all <i>By Besim Şişman, CEO and President of the Board, Turkish Petroleum Corporation</i>	48			Acknowledgements	145
Maintaining strategic reserves as a guarantee of security of supply <i>By Pedro Miras Salamanca, Chairman of CORES, Chairman of the Standing Group on Emergency Questions, International Energy</i>	52				

The opinions and views expressed by the authors in this book are not necessarily those of WPC, its members or the publisher. While every care has been taken in the preparation of this book, they are not responsible for the opinions or any inaccuracies in the articles. Unless otherwise stated, the dollar (\$) values given in the book refer to the US dollar.

The road ahead for the World Petroleum Council

WPC has a busy time ahead with events and charitable projects planned during a challenging era for the industry.

By Dr Pierce Riemer



It seems like only yesterday that we met up with our friends in Russia at the 21st World Petroleum Congress. Despite looming sanctions, we had one of our highest delegate turnouts and the largest ever World Petroleum Exhibition.

In Moscow, we talked about how the oil price had been remarkably constant for the last six years, despite many troubling world events. Little did we know that just a few months on we would be looking at lower oil prices and the challenges it now creates.

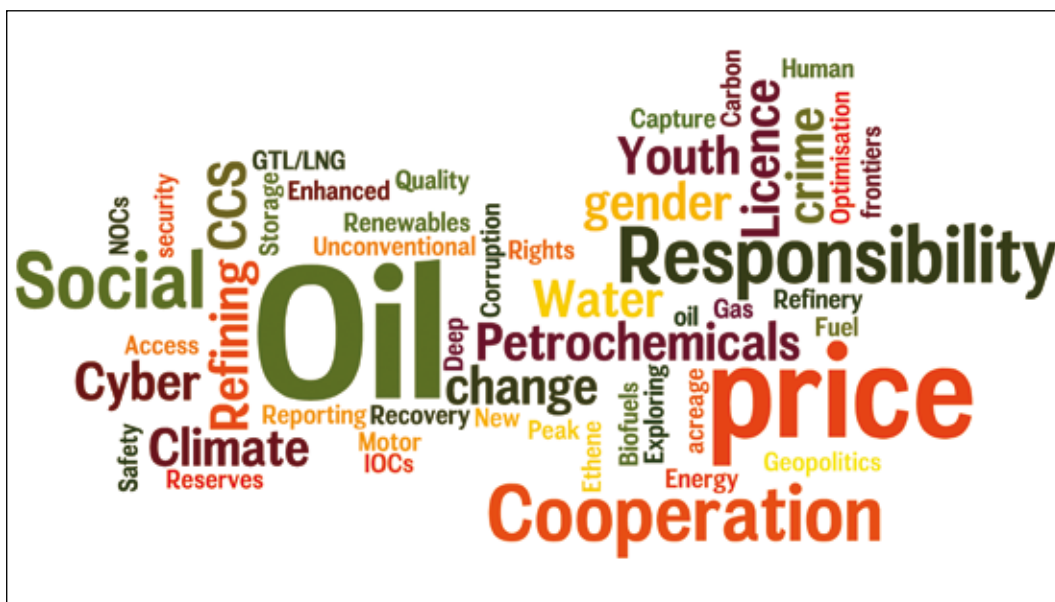
As a non-profit making organisation, the World Petroleum Council continues to use any financial surpluses for good, carrying on the mantra of our founder Thomas Dewhurst, who created WPC “for the benefit of mankind”. Despite being more than 80 years old, the original vision for the organisation fits well with the sustainability aims of today.

We recently asked our members for nominations for charitable projects that the Council should

support. The first one we selected is a vocational project in Pakistan. This project is aimed at local youth development through vocational training, in the Sindh Province of Pakistan. Over the course of two years, we are providing vocational training courses to 20 local students in disciplines such as fabrication, welding, pipe work, electronics, carpentry, masonry and plumbing. This will allow young people in the province to gain employment opportunities in local communities. We look forward to further nominations from our National Committees and to starting more projects in the years ahead.

Obviously, oil prices dominate thinking at the moment but it's interesting that "cooperation" and "responsibility" are also showing up prominently. This is important, as despite the low oil price, we must continue to operate in a safe and responsible manner wherever we are in the world. We also need to encourage young people to join our industry.

► WPC regularly surveys attendees at its events and the members' network. It is interesting to see what issues people are most concerned with. This word cloud is from one of the latest surveys.





These views are particularly apt as May 2015 sees the launch of our first WPC Leadership Conference focusing on responsibility, cooperation and sustainability. We have put together a first class line up of speakers and, despite the difficulties surrounding the current oil price, we will have a superb event against the backdrop of the Arctic Circle in Tromsø, Norway.

While we are in Norway, we will be continuing our dialogue with the OPEC Fund for International Development (OFID). Together we are engaging oil and gas companies in energy poverty alleviation and showcasing the contribution the petroleum industry can make in areas where it is operating. The results will feed into the United Nations Sustainable Energy for All programme (SE4All).

After Tromsø, the next big meeting is the WPC Annual Council meeting in India in October 2015. This gives all our members a chance to meet again, network, and for all of our International committees to meet. This time, as well as the Council meeting, the Indian National Committee will be hosting an expert workshop on "Carbon Emission Management: Upstream & Downstream Best Practices and Opportunities".

We are now well into the planning of the 22nd World Petroleum Congress, which will be held in Istanbul, Turkey, in July 2017. We have agreed a theme, "Bridges to our Energy Future", and exhibition and sponsorship sales have already commenced. At a recent meeting in Korea, our international Programme Committee developed the outline and structure for the 22nd Congress technical programme and we will be collecting nominations from our National Committees for the Chair and Moderator roles over the summer.

Our team at Turkish Petroleum is young, keen and very eager and you will see them around the world at key oil and gas events. Before the Congress in Istanbul, we will be holding our 5th triennial Youth Forum. This is being re-branded as the WPC Future Leaders Forum and will take place in Rio de Janeiro, Brazil, in 2016. So, as always, there is a lot going on and we look forward to seeing old friends and making new ones at WPC events over the coming months.

Dr Pierce Riemer is the Director General of the World Petroleum Council (www.world-petroleum.org).

◀ Dr Riemer and Dr Thomas Gangl, Chair of WPC's Austrian National Committee, signing the agreement to launch WPC's vocational project in Pakistan.

▼ Pakistani students learning vocational skills through the WPC Legacy course. Focusing on youth development will provide a strong grounding for future development.



The background of the slide is a photograph of an orange oil pumpjack in a field of sunflowers. The pumpjack is a large mechanical device used for extracting oil from the ground. It has a long, curved arm with a bucket at the end, and a counterweight. The sunflowers are in full bloom, with bright yellow petals and dark brown centers. The sky is a clear, pale blue. The overall image conveys a message of sustainable energy and technological innovation in the oil and gas industry.

Technological Innovation for Energy Solutions Today and Tomorrow



Leadership perspectives

- **József Toth, the World Petroleum Council President** focuses on responsibility, cooperation and sustainability as ongoing goals for the energy industry across the world. Next, we hear from leaders of some of the world's biggest energy companies.
- **Rex Tillerson, ExxonMobil's Chairman and CEO**, emphasises the need for cooperation between all stakeholders if serious progress is to be made in the areas of economic development and environmental responsibility.
- **Ben van Beurden, Shell's CEO**, calls for strong leadership as the energy marketplace becomes more complex and global energy demand continues apace.
- The importance of sustainability and mitigating climate change is the focus of the contribution by **Eldar Sætre, Statoil's CEO**. He outlines how Statoil can stay competitive while still being a responsible energy provider.
- **BP's new Chief Economist Spencer Dale** explains the main points of the company's Energy Outlook 2035, a projection of broad future energy trends that will affect the global marketplace in the years ahead.
- Offering a United Nations perspective is **Dr Kandeh Yumkella, Special Representative of the UN Secretary-General for Sustainable Energy for All**. Dr Yumkella highlights the unique position of oil and gas operators to drive the partnerships and action needed to end global fuel poverty.
- This section concludes with a case study from **Total** on access to energy in developing countries.



Leadership perspectives

The World Petroleum Council President outlines the challenges for the energy industry and his vision for the ongoing role of WPC in a changing world.

By József Toth



"Leading the Industry" is the theme for WPC's 2015 Yearbook, and as we focus on achieving a sustainable energy future, leadership is fundamental to delivering this objective. The current challenges faced by the industry are substantial and strong management is needed to address them – responsibility, cooperation and sustainability are the ongoing goals on which we must keep focused.

As the world population increases, access to affordable, safe and reliable sources of energy will be an important factor in promoting economic development and wellbeing for humankind. Oil and natural gas will continue to be the world's leading energy resources for the foreseeable future. Meeting subsequent demand in a sustainable and socially responsible manner will require massive investments, leading edge technologies, the highest skilled human resources, and superior ethical business practices. Producers, consumers, governments and societies need to cooperate responsibly to develop all energy resources.

With an expected world population of more than 9 billion by 2050, the biggest task for our industry will be to supply energy and products in a world with increasing challenges and uncertainties.

The energy map in general, and the oil production-consumption map in particular, are changing around the world, with a shift from west to east, where emerging countries are becoming key consumers, new producers will potentially appear due to technical advances in E&P and traditional consumer countries are becoming not only producers but also net exporters.

Good leadership, together with high standards and ethical business practices, are required to ensure the sustainable supply and efficient use of the world's oil and gas resources for the benefit of all. Increasing importance must be placed on industry leaders to achieve best available technology and

practices that ensure we minimise impacts and risks to the people and environments in which we operate around the world.

As the industry adjusts to lower oil prices, operators are forced to look more closely at investment strategies and assess development plans. So to survive and prosper, it is important to implement strong management at every level of our sector, not just at the top.

International cooperation is also essential for the new energy scenario. In this global and interdependent market, all stakeholders need to cooperate and collaborate to create commercial, operational and political synergies. To succeed, we also need to show flexibility as our opportunities change, with new technologies and innovations required as we work in deeper and more remote fields our industry is continuously challenged to find new resources and better technical solutions.

Currently, national oil companies own most of the world's oil reserves, while service companies have developed most of the new technologies and international oil companies have proven records for managing financial risk. Therefore, it is necessary that they work closely together to sustain the investment levels required to meet rising oil demand. Companies and their leaders have developed innovative solutions to challenging projects. NOCs, IOCs and service companies have to cooperate to reduce the technological challenges as well as improve on safety, production and capital efficiency.

As one of the largest sectors in the world economy, the oil and gas industry needs considerable investment to sustain the costs of providing a sustainable supply of petroleum and petroleum products. Strong leadership ensures continuous and smart investment in new technologies, increased production and the enhancement of product quality.

Figures stated in the International Energy Agency's 2014 World Energy Outlook showed that annual investment in upstream oil and gas rises in the New Policies Scenario by a quarter to more than \$850 billion by 2035, with gas accounting for most of the increase. The report also states that more than 80% of the cumulative \$17.5 trillion in upstream oil and gas spending is required to compensate for decline at existing oil and gas fields.

WPC and its members, representing more than 95% of the world's oil and gas consumption and production, are focused on the management of the world's petroleum resources and their sustainable development for the benefit of humankind. Developing innovative technological solutions and focusing on active stakeholder engagement supports this goal.

Historically, the Council has created platforms for all stakeholders in the petroleum sector to get together and address these fundamentally important issues. The triennial World Petroleum Congress, which covers all aspects of the industry from technological advances in upstream, downstream

and petrochemical operations to the role of natural gas and renewables, management of the industry and its social, economic and environmental impact, has now been joined by the addition of the WPC Leadership Conference which focuses on responsibility, cooperation and sustainability.

Recent and future Congress themes support the importance of sustainable development, leadership and building bridges to the global energy future. By engaging our members through our official publications and the Congress programme, we have been able to develop and publish positive outcomes and recommendations for the industry.

Our official publications are one-off editions which focus on major technical, social, environmental and management challenges impacting global energy issues. In addition to our yearbooks and Congress publications, we have also developed an educational series on specific topics which provide an introduction or overview on areas such as unconventional oil and gas, Arctic oil and gas development, and petrochemicals and refining.



◀ WPC President, Dr József Toth, with his leadership team.



WPC acts as a catalyst and facilitates dialogue among stakeholders, both internal and external to the petroleum industry on important economic, social, environmental and management issues in order to contribute towards seeking solutions. As such, WPC is a forum, bringing together the various sectors of society that have views on specific issues, and it actively encourages industry leadership.

One of these issues is health and safety, which is of paramount importance to our industry. Ongoing focus on the reduction of oil spills, injuries and accidents, and the persistent improvement of safety standards through leadership, cooperation and communication are all priorities. Commitment from the top will ensure adherence to safety at all levels.

Encouraging diversity also gives strength to our industry. It is positive to see the gender gap closing but we still have more of a way to go. Starting at the top, companies should make the development of their leadership pipeline for female staff a priority. Increasingly, women can be found on rigs, at refineries and, more significantly, in positions where

their authority and influence can have a substantial impact on the industry's future.

As we look at the long-term outlook, cultivating tomorrow's leaders and mentoring the next generation must always be a priority. We, as an industry, are responsible for moulding these young minds, and through them we can safeguard our legacy for sustainable energy. The energy of young people is a driving force for global sustainable development and the industry has to energise its professionals, in particular the younger ones, to become even more innovative in ensuring future growth.

We recognise the ongoing importance of providing a platform for open discussion between consumers and producers, governments and industry, academia and financiers, leaders and society. The 22nd World Petroleum Congress will be hosted in Istanbul in 2017 with a focus on "Bridges to our Energy Future". Partnerships, technical innovations, human ingenuity and strong leadership provide the cornerstones on which to develop solutions that enable a secure energy supply for our future, in a reliable, secure, affordable and responsible manner – these issues will be taken forward at the Congress.

By engaging the industry and the wider public through our official publications, WPC strives to provide a valuable source of industry information and an opportunity to consider the global challenges we face. We are delighted to present you with perspectives from a diverse and respected selection of industry representatives who have generously shared their views on leadership in technical innovation, responsible operations, global cooperation and sustainability.


If, through strong and consistent leadership, we can raise standards across the globe for responsible operations, showcase best practices, share experiences of managing safe operations in challenging environments and demonstrate the industry's commitment to our environment and sustainability, then we are meeting our goals.

József Toth is the President of the World Petroleum Council (www.world-petroleum.org).

▼ Encouraging youth engagement will provide a solid foundation for the future of the industry.



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The oil industry as an innovator and leader

Meeting the energy industry's economic and environmental challenges will require cooperation between all stakeholders.

By Rex W. Tillerson



This is an historic moment for the global energy industry – one that holds great promise for the future of billions of people around the world. As you will read in the pages to come, leaders from the energy industry are transforming the world by expanding supplies in safe, secure and environmentally responsible ways. We are developing new energy resources in some of the most challenging places on earth. And we are advancing innovative technologies and partnerships at every link in the global energy value chain.

The fundamentals of fruitful energy dialogue

To understand the significant transformations taking place, the proper starting point is to recognise that the need for energy is universal.

Safe, affordable and reliable energy has the power to change the world for the better. Energy

opens up trade and transportation, improves health-care and sanitation, and expands educational and individual opportunities in unimagined ways. Energy is the lifeblood of economic growth and technological progress, and we will need to pursue all sources of energy – wherever they are economically competitive – in order to meet growing global needs. The world will need wind, solar, nuclear, coal and hydro supplies. But because of their flexibility, reliability and sheer energy density, oil and natural gas will continue to be critical to meeting growing energy demand.

By the year 2040, the global population is projected to increase from about 7 billion to about 9 billion people, and the global economy is expected to more than double. Energy demand will increase by about 30% to support growth in trade, development, and urbanisation. This increase in demand is equivalent to the current energy con-

► Energy in all its forms is vital for continued economic growth and technological progress.





sumption of Russia, India, Africa, Latin America and the Middle East combined. There is good news behind these trends. There will be enormous growth within the world's middle class. In fact, the Brookings Institution, a respected US public policy group, estimates that 2.8 billion people will join the middle class between 2010 and 2030. But this will not happen without the abundant energy supplies that fuel the global march to progress and prosperity.

The recognition that there is a universal need for energy should influence our energy dialogue in another way. Government and industry leaders must see that there is a humanitarian imperative to our current efforts to expand energy supplies. According to the latest figures on global energy poverty, about one in five people have no access to electricity. About two out of five people must rely on biomass, such as wood, charcoal or animal waste, for basic cooking and heating needs. The costs in terms of human lives lost are steep. The World Health Organisation estimates that every year, approximately 4.3 million people around the world die from household air pollution caused by exposure to indoor stoves or fires used to cook food or provide heat.

Simply put, in the decades ahead, billions of people's lives will depend on the investments, innovations, and collaborations that the energy industry makes now. For this reason, it is important to understand the changes influencing energy markets today, and what industry and government must do to meet the energy and environmental challenges of the future.

Transformation through innovation

The momentous transformation taking place in global energy markets right now is the direct result of decades of industry innovations. These evolutionary and revolutionary technologies are so consequential that they rival even the dramatic exploits and achievements of our industry's earliest pioneers. We can now safely drill for oil and natural gas where it was previously thought to be too expensive, too deep, or simply impossible to reach.



In Canada, investment and innovation have made it possible to economically develop vast oil sands deposits, giving society access to a resource base of approximately 170 billion recoverable barrels. That is equivalent to the energy needed to fuel today's North American personal vehicle fleet for about 45 years. And contrary to what some claim, the greenhouse gas emissions from oil sands development are similar to many other heavy crudes from places like California and Venezuela.

In the Gulf of Mexico, Africa and elsewhere, advanced technologies have enabled us to reach unprecedented offshore energy resources. In less than a generation, we have progressed from concepts on a drawing board to computer-designed rigs that can operate in ultra-deepwater depths of more than 1,500m below the ocean's surface, and that can drill another 8km below the ocean's floor. Over the next 25 years, we expect that the industry will nearly double deepwater production worldwide.

In the Arctic and sub-Arctic, our industry continues to press forward in the world's largest remaining region of undiscovered conventional oil and natural gas. Most of this resource lies in water less than 100m deep and where we have proven production technology and experience. In the decades ahead, the Arctic will play an increasingly important role in meeting global energy needs. It has been a major oil and natural gas producer for nearly a century – and with our decades of

▲ Canada's abundant oil sands would not have become a viable source of energy without innovative recovery techniques.



▲ Arctic and sub-Arctic regions have great potential to meet future energy requirements.

experience and expertise in the Arctic and sub-Arctic, we know we can harness this energy safely and responsibly.

In North America, we have seen the extraordinary potential of our industry's technologies in the widespread application and advanced integration of hydraulic fracturing and horizontal drilling. Tight oil and shale gas, once considered uneconomic and inaccessible, are bringing vast new supplies to market, re-shaping the North American energy landscape, and, with it, the world.

Taken together, all these innovations on different frontiers are ushering in a new era of abundance. New supplies of oil and natural gas are increasing energy diversity, enhancing flexibility and strengthening security. In fact, the dramatic increase in production has already helped to offset supply losses due to geopolitical upheaval and economic mismanagement in some of the most important oil-producing countries. Because of these new supplies, energy prices began to decline in the latter half of 2014 as markets readjusted to new supply-demand realities.

For our industry, the current downward swing in prices will create pressures, and far-sighted

decisions will have to be made. Companies will need to focus even more on the fundamentals of investment and financial discipline. We will also need to find ways to work together to apply new technologies and innovative thinking. For the companies that can find these efficiencies, there will be tremendous opportunities ahead.

Unlocking environmental benefits

The essays in the pages that follow will show that the global energy industry is not just dedicated to applying new technologies to expand supplies, we are dedicated to doing so in ways that are safe, secure and environmentally responsible.

Human ingenuity and innovation have always been – and will always be – vital for improving performance and to better managing the risks associated with increased energy use. In North America, we have already seen new supplies of natural gas bring extraordinary environmental benefits. This is due in large part to the shift from coal to natural gas in the power-generation sector.

When electricity is generated with natural gas, carbon dioxide emissions can be up to 60% lower than electricity generated with coal. In fact, abundant and reliable natural gas has helped reduce US carbon dioxide emissions to levels not seen since the mid-1990s. These reductions are especially impressive considering that the US economy is 60% larger than in the 1990s and has 50 million more energy consumers. With sound energy policies, increased investment and collaboration, natural gas can help other nations achieve meaningful reductions.

The advances in our industry have led to impressive results in other areas of environmental stewardship – even as we meet energy needs. For instance, the US has seen significant declines in methane emissions. The reductions have occurred even as oil and gas production in the US has risen dramatically. Recent studies by the University of Texas show that methane emissions at hydraulic fracturing sites are low – much lower than previously thought by scientists and environmental agencies.



◀ Hydraulic fracturing and horizontal drilling techniques have completely changed the North American energy landscape in recent decades.

Global growth and the need for collaboration

The pages ahead will explore some of these historic developments. But as readers consider and weigh these advances, they should contemplate a few broader implications about how the world can best achieve our shared ideals and objectives for economic growth, environmental protection, and the benefits to humanity that are made possible by abundant energy supplies.

The question for leaders from government, industry and the public at large is no longer whether some resources can be developed safely. The question is: How can we encourage the technologies and collaboration that can continue to expand supplies, increase efficiency, and improve environmental performance?

The answer is simple: we must establish sound and visionary energy policies – policies that support investment, ingenuity and innovation.

Governments will always have a special role to play in this effort. Only governments are positioned to promote and enforce the rule of law, open borders for trade, and provide resource access for those competing to serve consumers safely and

responsibly. Only governments can establish and maintain a stable legal, tax and regulatory environment that will encourage long-term planning and investment. And only governments can put in place policies that recognise the variability in global prices and enable oil and gas projects and partnerships to be structured in a way that can help companies plan for the ups and downs of the business cycle.

By putting in place sound policies, government leaders and policymakers can help spur the investments and long-term partnerships that maximise value, increase efficiencies and contribute to sustained and responsible growth.

Our industry has proven – and continues to prove – that our application of new technologies and cooperation can unlock new supplies of energy. It is through such abundance and reliability that we can help reduce global price volatility, moderate international tensions and provide the energy flexibility and security that enables peaceful nations to trade and advance together.

Rex W. Tillerson is Chairman and CEO of the Exxon Mobil Corporation (www.exxonmobil.com).



The energy industry's role in meeting supply and environmental challenges

Shell's CEO calls for strong leadership from the energy industry in today's complex marketplace.

By Ben van Beurden



In January 2015, Barack Obama gave his State of the Union address. It took him less than two minutes to mention oil – and if he hadn't been interrupted by applause, he would have got there even faster. This shows how important oil is to advanced economies.

We all know why. Oil is an essential part of the energy mix. And energy, in turn, is the lifeblood of human existence. Without energy, our lives would be almost unrecognisable. I'm proud to be part of an industry that truly powers economies.

The future of our industry, both in the short and the long run, needs to be discussed in detail. Oil prices will, of course, be an important issue throughout the year. Since summer 2014, the price of Brent Crude has plunged. Higher shale production in the US, an unwillingness by OPEC to cut its own production, and a slowdown in energy demand in China – these are just some of the factors shaping a complex situation.

Low prices have big implications for exporting countries like Iran, Russia and Venezuela, shale producers in the US, and even for domestic budgets of

producers in the Gulf states. In consuming nations, low oil prices are an economic boon stimulating growth and demand.

I can't predict the future, but oil demand is clearly linked to economic growth. Compared to 2014, the International Monetary Fund expects the global economy to grow. So, global oil demand is expected to grow as well. But seeing today's prices, supply will probably not keep pace with this growth. It may even decline, as prices are close to cash costs, according to consultants such as Wood Mackenzie. As a result, energy companies could shut down some of their existing production.

If the brighter economic outlook becomes reality, the market could tighten, and this would support higher prices. But two questions remain. Firstly: How far and how long will prices fall? Secondly: How quickly can prices recover?

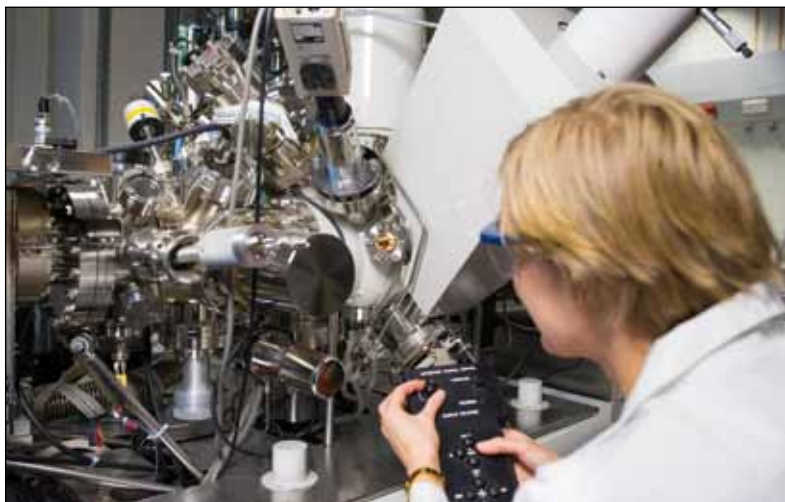
A rapid recovery could occur if projects are postponed or even cancelled. This would lead to less new supply – not so much in 2015, but in two or three years. Combined with economic growth, the market could tighten quickly in this scenario.

But what if the largest supply growth engine, US shale oil, proves to be resilient in the face of falling prices and the markets remain well-supplied? In that case, with moderate economic growth, prices could stay low for longer.

Either way, the market will remain volatile in 2015, if only because for now OPEC shows no sign of wanting to resume its role as swing supplier. But for the longer term, I see no change to fundamental drivers of oil markets, such as rising demand and the need for new supplies.

Our "New Lens Scenarios" are among the tools Shell uses to look at the future. Shell has been using

▼ Developing new technological solutions to the world's energy needs is a cornerstone of Shell's business.



scenarios since the 1970s to allow its leaders to make good business decisions. The Shell Scenarios have gained a worldwide following among governments, academia and other businesses. In the two New Lens Scenarios, “Mountains” and “Oceans”, it is projected that oil demand will continue to grow for at least two decades.

And then, of course, production from oil fields typically declines at a rate of at least 5% a year. This means that the need for new supply could be as high as 5 million barrels a day, year after year until at least 2030. This amount of supply cannot be delivered by OPEC or shale oil producers in the US alone. It will need to come from new and challenging areas, and it has to be supported by an oil price that justifies huge investments.

The oil price will remain an important issue throughout the year. While a boon to consumers, these are tough times for some producers. But at Shell, we’re determined to avoid a start-stop approach to investment. Shell will remain a large investor in 2015, with a strong focus on costs. Additionally, we will continue to invest in research and development. R&D is our sector’s lifeline at a time of energy transition.

A sustainable energy future

2015 is an important year in that transition. At the end of the year, the UN’s Climate Change Conference will be held in Paris. In the run-up to this conference, the climate debate will rise to new heights of intensity. The outcome of the political process is uncertain, but the trends behind it are unmistakable. Even more than the oil price, these trends will shape the future of the industry over the coming decades.

For a sustainable energy future, we need a more balanced debate. Fossil fuels out, renewables in – too often, that’s what the debate boils down to, but in my view, that’s simply naïve.

Yes, climate change is real. And yes, renewables are an indispensable part of the future energy mix. But no, provoking a sudden death of fossil fuels isn’t a plausible plan. Today, 3 billion people still lack access to the modern energy many of us take



for granted. This isn’t just about having a vacuum cleaner or a television set. Energy access often makes the difference between poverty and prosperity.

At the same time, demand is growing. There will be more people on this planet, more people living in cities and more people rising from poverty. They will all need energy if they are to thrive. The issue is how to balance one moral obligation, energy access for all, against the other: fighting climate change. We still need fossil fuels for a lower-carbon, higher-energy future.

It is, of course, true that the use of renewable energy is growing, especially in electricity markets. However, it will take some time before renewables can play an equally important role in transport, and the heating and cooling of people’s homes.

This is our chance to get ready. To discuss opportunities for new forms of energy or energy transport, Shell has a Future Technology Group. It reports directly to me, because I believe that future technology is crucial to the future of Shell.

Exploring new horizons now is our chance to be a constructive part of the energy system later — both through the products and services we offer,

▲ Shell’s New Lens Scenarios see oil demand continuing to grow for the foreseeable future.



and our contribution to the debate. In the meantime, however, the world's energy needs will underpin the use of fossil fuels for decades to come. So, rather than ruling them out, the focus should remain on lowering their carbon emissions.

Three things are crucial to achieving the goal of reducing carbon emissions from fossil fuel producers and consumers. Firstly, a shift from coal to natural gas is required. When burnt for power, gas produces half the CO₂ coal does.

Secondly, carbon capture and storage (CCS) needs to be ramped up. CCS fitted to power plants can be a real game-changer. An example of this is our project under design at Peterhead in Scotland. CCS can remove up to 90% of CO₂ emissions from power generation.

Thirdly, and most importantly, a well-executed carbon pricing system is essential. This would help promote natural gas as well as CCS, and a whole range of other low-carbon technologies.

Despite some encouraging signs, we are a long way from achieving these three objectives. The debate – driven by NGOs – still revolves around emission targets, whereas the policies needed for meeting those targets are often overlooked. As a result, ineffective, inefficient or even counter-

productive measures are taken in some countries and regions.

Take Germany, the largest economy in Europe, for example. The good news is that renewables, with strong support from the German government, are growing. The bad news is that coal plants are used as a flexible back-up. That has caused CO₂ emissions in Germany to actually increase in 2012 and 2013, according to the European statistics agency Eurostat. This is bizarre and demonstrates the issues we face.

Informed debate

What can we as an industry do to help clear the way for a more informed debate? In the past, we thought it was better to keep a low profile on the issue. I understand that tactic, but in the end it is not a good tactic. The debate about the future of energy is not always very balanced, partly because we keep such a low profile and there is so little dialogue within our sector.

Our industry should be less aloof and more assertive. We have to make sure that our voice is heard by members of government, by civil society and the general public. I am aware that the industry's credibility is an issue. Stereotypes that fail to see the benefits our industry brings to the world are short-sighted. But we must also take a critical look at ourselves.

You cannot talk credibly about lowering emissions globally if, for example, you are slow to acknowledge climate change; if you undermine calls for an effective carbon price; and if you always descend into the "jobs versus environment" argument in the public debate.

So, to make our voice heard, the energy sector needs to enter into the public debate alongside other credible parties – ranging from academics to non-governmental organisations and policymakers. Together, we can offer some realism and practicality to the debate.

Ben van Beurden is the CEO of Royal Dutch Shell plc (www.shell.com).

▼ Shell is developing a carbon capture and storage project with SSE at the Peterhead power station in Scotland.



87 years of Expertise

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Exploration and Production





Setting a sustainable growth agenda

Statoil's CEO outlines the company's commitment to sustainability and environmental responsibility.

By Eldar Sætre



▼ One of two subsea gas compressors for the Åsgard field. This technology is one of Statoil's most important measures for delivering volumes from existing fields on the NCS, increasing recovery from the Mikkjel and Midgard gas reservoirs by around 282 million barrels of oil equivalent.

Statoil was "born" in 1972, at the very beginning of what has developed into a Norwegian oil adventure. At that time – being fully owned by the Norwegian government – Statoil's mission was to contribute in accomplishing some clear political targets – turning the below ground value of the hydrocarbons in the Norwegian Continental Shelf (NCS) into real value for the country of Norway to the benefit of the whole population, and contributing to build a competitive, national oil and gas industry for the long term. More than 40 years later, I think it's fair to say "mission complete". The oil and gas industry is by far the most important industry in Norway, employing around 250,000 people.

Statoil – now a listed company – produces almost 2 million boe/d and is among the 10 largest listed oil and gas companies in the world. Revenue from the oil and gas sector represents around 25% of Norway's GDP, and Norway has – thanks to the oil

and gas sector – developed into one of the richest countries in the world.

Statoil's profile is quite distinctly a technology-driven upstream company. The technology focus has been our legacy throughout the history of the NCS, and today we are recognised for our innovative, sustainable approach.

Delivering more energy – while reducing emissions – demands a new approach towards the future. We are required to put our power of innovation to work to tackle a new set of challenges.

In this article, I want to briefly lay out three of these challenges, with the headlines: Competitiveness, Carbon and Communities, the three Cs.

Competitiveness

Within our industry we are all used to competing for capital, for resources and for talent. My main message is that the competitiveness of our industry must improve.

We cannot decide on the oil price; so that means costs must come down significantly. During recent years, the effects of a high oil price became visible almost everywhere, except in oil companies' financial results. In the decade leading up to 2014, the oil price almost tripled, due to escalating investment and increased cost and complexity. Return on capital from the majors decreased on average by one-third. So as an industry we have no choice but to become more competitive.

At Statoil, we have addressed this through a wide-ranging programme we call STEP – Statoil Technical Efficiency Programme – and one of several major tasks is to optimise how we work with our suppliers. We have specific improvement agendas with most, if not all, of our suppliers. The main success criterion





for Statoil and our suppliers is a substantially lower cost of product and services, driven by even better cooperation, simplification of how we work and standardisation whenever possible.

Carbon

In 2014, the UN's Intergovernmental Panel on Climate Change (IPCC) published several reports. They confirmed that climate change is real and it is happening right now. Based on observed impacts, the IPCC identified eight main risks, and it's not very pleasant reading. Extreme weather will have a significant impact on people's living conditions in coastal areas. It will lead to severe ill-health for urban populations and the breakdown of infrastructure, such as electricity, water and healthcare. Observation clearly confirms that we have already seen the first consequences of this development.

As we speak, sustainable energy for all is moving up on the political agenda. And rightly so. Currently, 1.3 billion people still lack access to electricity while CO₂ levels continue climbing to new all-time highs. Some tend to take a "let's just wait and see" approach to climate change. In Statoil we're not among those. It is too big a risk. To avoid a development where the 2°C scenario becomes a reality, we need new political measures.

Now is the time to strongly advocate high ambitions as well as incentives that support investments in carbon efficient solutions. In Statoil, we strongly believe in a high global price on carbon. This would lead to more natural gas replacing coal in power generation, reducing CO₂ emissions by up to 70%. Additionally, it would give incentives for reducing emissions from flaring and methane leakages.

Leading up to COP 21 in Paris in December 2015, now is the time for our industry to join forces to demonstrate how we can be part of a sustainable solution. Now is the time to engage with policy-makers to enable the right kind of regulation.

Communities

With the easily accessed barrels more or less gone, our industry is set to gradually enter more sensitive



areas. These include ultra-deep offshore, onshore in the US, and in areas where oil and gas development represents something new and potentially challenging – like for us in Tanzania.

This exposes us to a new set of stakeholders, expectations and requirements from communities, regulators, governments and NGOs. People care about what we do because what we do matters to them. We need to meet these expectations through the products we deliver and through how we perform our business. Therefore, we must interact effectively with society, locally as well as with the general public, and we must become even better at doing this in the future.

This approach of the three Cs forms the background for why Statoil focuses strongly on innovation and collaboration. We definitely live in challenging times. Yet it's also a time of opportunity.

Energy is at the heart of supporting the future for billions of people across the world, and our industry is constantly discussed by politicians and regulators across the world. As an industry, we have a fantastic opportunity to contribute with our competence, technology and collaborative approach.

Our products are part of the source of climate change – part of the problem. Therefore we need to be part of the solution. That's the ambition we have at Statoil.

▲ Statoil captures about one million tonnes of CO₂ a year from the natural gas in the Sleipner field in the North Sea and stores it in a formation more than 800m below the seabed. This ground-breaking project has provided the company with considerable expertise and experience in geological CO₂ storage.

Eldar Sætre is the CEO of Statoil (www.statoil.com).



Energy trends in a world of growing demand

BP's new Chief Economist discusses oil prices and world energy trade patterns from projections made by the company's experts.

By Spencer Dale



BP's Energy Outlook 2035 is not a "crystal ball", rather it is a projection of broad future energy trends. The main message is that we expect energy demand to grow by almost 40% over the next 20 years, with the vast majority of growth coming from fast-growing developing economies such as India and China. Fossil fuels will continue to supply the lion's share of that demand, particularly gas which we expect to be the strongest growing fossil fuel.

The Energy Outlook provides an opportunity to lift our heads from concerns about the here and now, and consider the broad trends that are likely to affect energy markets over the next 20 years or so. Understanding these longer-term trends is critical for a company like BP when it is undertaking strategic planning and long-term investments. It is also hopefully helpful for policymakers around the world tasked with thinking how best to regulate and structure energy markets in the future.

To the extent that the Energy Outlook provides any guide to the current weakness in oil markets,

the underlying message is that the factors giving rise to the current weakness in oil prices will slowly fade over time. Growth in US oil production is likely to slow down, world demand for oil will gradually pick up and, over a period of time, this current weakness in oil prices will gradually dissipate. But that process is likely to take several years.

Projections for the natural gas market

It is also worth examining what the main likely developments for the natural gas market will be over the next 20 years. We think we are going to see strong growth in the supply of gas, both from conventional and unconventional sources. In particular, US shale gas will continue to grow rapidly.

The other interesting feature is the increasing global supply of liquefied natural gas (LNG). The importance of LNG is that it is mobile – it can be transported to a number of different countries depending on relative needs and prices. This has major implications in terms of how gas prices are likely to be set across the world, with gas prices in different markets starting to move in greater unison. It also has important implications for the diversity of sources of supplies available to large gas importers, who currently are largely reliant on pipeline supplies.

Changes to global energy trade patterns and the energy mix

The Energy Outlook shows a shift in the world's energy trade patterns. For many years, energy, particularly oil, has flowed from the Middle East into energy-thirsty economies in Europe and in America. What we expect to see in the next 20 years is those trade flows starting to reverse. In part, that

▼ LNG's mobility has great importance for diversity of supply and the future of gas pricing mechanisms.





reflects the increasing supply of gas and oil in North America. This trend also reflects the increasing gains in efficiency we've seen in Europe and the US. Improvements in efficiency mean that demand for energy in the major OECD economies is expected to be broadly flat over the next 20 years. It also reflects the fact that we expect to see rapid growth in GDP and energy demand in much of Asia in the coming two decades.

As well as the major changes expected to take place within trade patterns, we expect to see a quite significant shift in coal. In the past 10 years or so, coal has seen the most rapid growth of all fossil fuels, driven particularly by China, but this fast pace of growth is not projected to last. In the next 20 years, we expect coal to become the slowest growing fossil fuel, partly as Chinese industrialisation slows, and as a result of increasing environmental regulation.

We also expect significant growth in non-fossil-based sources of energy, with renewables standing out. We expect renewables to grow, on average, by around 6.5% each year, for the next 20 years. As a result, they will increase their share in primary energy from around 3% now to around 8% by the end of 2035.

The outlook on carbon emissions and climate change mitigation

The projected increase in carbon emissions in the Energy Outlook is higher than the scientific community tells us is needed to limit the rise in the world's temperature to 2°C. So, the central message from the Outlook is that more needs to be done.

Three additional messages come out of our analysis. First, no single initiative or improvement is likely to be sufficient on its own. Second, it is really hard for policymakers to pick in advance which of those improvements will be a winner. Third, the best way to pick those winners and losers is to let the market decide; for policymakers to take steps that result in a meaningful global price for carbon. That would provide the incentives for everybody to play their role in reducing carbon emissions – energy companies in terms of the types of fuel they



produce and energy consumers in terms of the types of energy that they demand.

▲ In the US, shale gas's rapid growth is predicted to continue while oil production ebbs.

The role of the Chief Economist at BP

The role of Chief Economist at BP is an interesting and varied one. Partly, it is to provide a centre of expertise within BP to help people better understand both the near-term – for instance, what is happening to energy prices – and the longer-term trends – what is likely to happen to the development of oil and gas markets when thinking about the strategy. That information is shared and discussed with other parts of BP to help everyone better understand the wider context and to see how it might help run those businesses more efficiently. A third aspect is to help maintain the role BP has established over many years as an objective thought leader in the world's energy markets.

This was the first time I have presented the Energy Outlook for BP. I still have a lot to learn about the industry but I was very proud to be heading up this exciting and important project. It is an impressive product produced by a world-class team of economists and centres of expertise throughout the organisation. It is very much a 'team BP' effort.

Spencer Dale is the Chief Economist for BP (www.bp.com).

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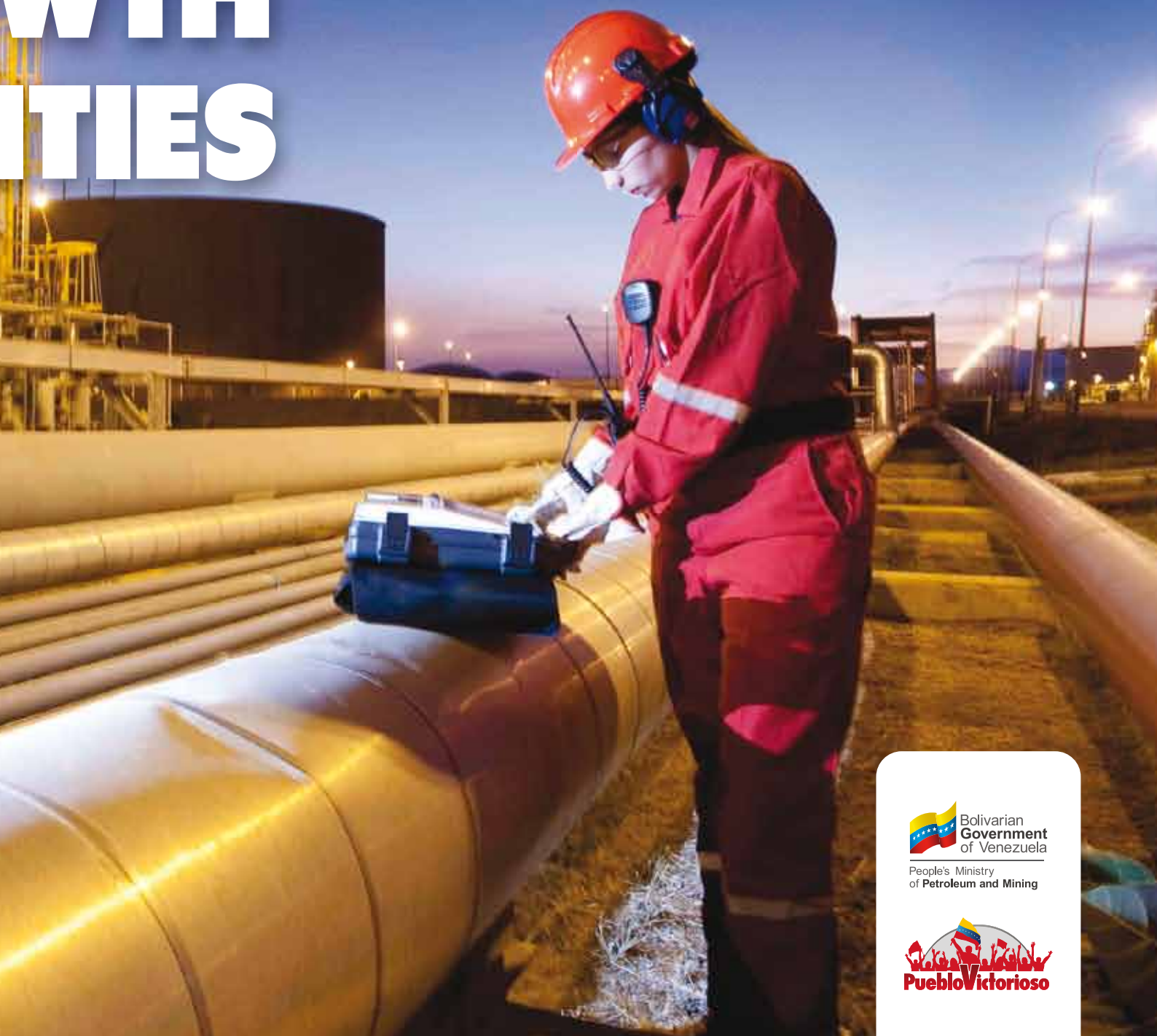


PARTNERS

21



OIL BELT, WITH ITIES



 Bolivarian
Government
of Venezuela

People's Ministry
of Petroleum and Mining

 **Pueblo Victorioso**



The challenge to achieve sustainable energy for all

Why sustainable energy for all matters, and how the oil and gas industry can help.

By Dr Kandeh
Yumkella



▼ Around 2.8 billion people around the world rely on solid fuel such as wood for cooking and heating. Use of these fuels indoors is a major cause of premature death, especially for women and children.

If there are two things that stand out as the great challenges of our time, they are poverty and climate change. And if there is a master key to unlock solutions to both these problems at the same time, it is sustainable energy.

In spite of rapid strides made by a few countries, more than one billion people – nearly one-fifth of the world's population – still live without electricity. About 2.8 billion people depend on traditional solid fuels such as wood, coal or animal dung for cooking and heating. The indoor air pollution caused by these fuels causes 4.3 million premature deaths every year, mainly women and children.

Without clean, efficient, affordable energy, people's chances of a better life are blocked at every turn. Without light after sunset, children cannot see to study and doctors cannot effectively treat patients. Women who spend hours a day fetching firewood have no time for more productive activities. Businesses are hampered, employment potential lost.

At the same time, extensive energy use (and waste), especially in high-income countries, creates

pollution, emits greenhouse gases and depletes non-renewable fossil fuels. Developing economies, including population giants such as China and India, are entering their most energy-intensive phase of growth as they industrialise, build infrastructure, and increase their use of transportation.

The pressures are rising. By 2050 the world's population is projected to reach around 9 billion – about two billion more people than today, all of whom will need energy.

Current energy systems are failing to meet both challenges. Providing economic opportunity for all, while at the same time protecting our environment from climate change, air pollution and dwindling natural resources, will require focused global action and investment that go far beyond current levels.

That is why in 2011, UN Secretary-General Ban Ki-moon launched the Sustainable Energy for All initiative (SE4All), a wide-reaching, multi-stakeholder partnership that brings governments and international organisations together with business, industry, finance and civil society, pooling resources and know-how to drive concrete action and fresh solutions.

SE4All's three global targets of ensuring universal access to modern energy, doubling the global rate of improvement in energy efficiency and doubling the share of renewables in the global energy mix – all by 2030 – provide an ambitious but achievable roadmap for ending energy poverty while at the same time cutting energy-related emissions.

Scientists have confirmed that these targets, taken together as a coherent package, are compatible with a global temperature rise of no more than 2°C, the target ceiling beyond which we would start to see a catastrophic impact.





◀ Energy generation from fossil fuels, particularly in high-income countries, is a major contributor to pollution and anthropogenic climate change.

Although feasible, action to achieve these targets will not come cheaply. To meet them, SE4All's high-level Finance Committee estimates that total investment of around \$755 billion per year will be needed across the three areas of energy access, energy efficiency and renewables, compared with current annual outlays of just over half that sum.

Such investment cannot be mobilized by the public sector alone: we need an integrated, multi-

stakeholder approach. As well as mobilising funds, governments have a major role to play in establishing the structural and policy conditions that allow private investment to flow. Businesses and financial institutions in turn can find new economic opportunities while supporting the greater good.

By facilitating relationships between public and private players, drawing on the broad convening power of the United Nations, SE4All acts as a cata-



◀ The official opening of the SE4All offices in Vienna in 2014. SE4All has partnered with developed countries and over 85 developing countries since the launch of the initiative in 2011.



▲ BG Group has teamed up with the Tanzanian government and an international development charity to help young people in the southern regions of Mtwara and Lindi become more employable.

lyst for necessary reforms, public-private partnerships and innovative new financial approaches.

Oil and gas companies: part of the solution

In the charged context of poverty and climate change, “Big Oil” is often viewed with hostility as a fundamental part of the problem. Yet with its business knowledge, convening power and capital, the oil and gas industry can be an integral part of the solution.

National oil companies typically have an explicit mission to support broader economic well-being in their country. Saudi Aramco’s “golden quadrant” strategy, for example, assesses the value of projects based on how well they meet three priority criteria: responding to the global energy market, commercial considerations, and national development.

But international oil and gas companies, too, have a vested interest in tackling energy poverty. The oil and gas industry has a long history of operating in sub-Saharan Africa and developing Asia – areas that are home to the vast majority of people without electricity or clean cooking solutions. In order to secure operating licences in these regions, companies are typically obliged to invest in local economies, and they have a business need for stability to ensure continued access to reserves.

Focusing corporate social spending on improving energy access not only helps to unlock development and economic opportunity for local

people, but benefits companies as well. It enhances a company’s social licence to operate – its compact with both governments and local communities – helping to secure operations and ensure stability on the ground. Bad relations with the host country can be very bad for business; good relations help to enhance brand, both locally and in terms of wider reputation.

In the longer term, oil and gas companies also stand to benefit from new market opportunities estimated to be worth some \$37 billion, as local communities become more prosperous and markets develop for products such as liquefied petroleum gas (LPG) for cooking – an efficient and safe alternative to polluting and dangerous solid fuels.

The oil and gas industry has experience of building stakeholder relationships, and know-how that can be deployed beyond the confines of the production site. Companies skilled in building the infrastructure needed for their operations in isolated areas, such as electricity mini-grids, can leverage their presence and know-how to provide energy access to local communities at minimal extra cost.

Many companies are already active in tackling the challenges of energy poverty. Take the example of the Bonny Island Utility Company in Nigeria. Set up as a collaboration of locally active industry players, including Shell, ExxonMobil, Total, Eni and Bonny LNG, working with the local community and

the national government, the utility has delivered affordable energy to more than 10,000 households. Its governance structure gives equal representation to the three stakeholder groups – community, government and private sector – and is in turn supporting better healthcare and education as well as small local businesses.

But there is far more that can be done. Management consultancy Accenture, a close partner of the SE4All initiative, has identified five areas where the oil and gas industry have major opportunities to support SE4All's targets.

First, companies can look for ways to use more renewable energy and emphasise energy efficiency throughout the whole fuels supply chain. Norway's Statoil, for example, sees wind power as an exciting new growth area for its business, leveraging its expertise in offshore operations.

Second, it is vital to reduce wasteful and polluting gas flaring and identify opportunities to re-use captured gas, either on-site or to provide energy to local communities. In sub-Saharan Africa alone, the annual amount of gas flared is equivalent to half the continent's power consumption. SE4All is working with the World Bank and other partners to promote the phase-out of gas flaring by fostering cooperation along the whole gas value chain, both upstream and downstream.

Again, individual companies are already taking action. Statoil, for example, has set a flaring intensity target for 2020 of a maximum two tonnes of gas flared per 1000 tonnes of hydrocarbons produced. Eni is using captured gas from its M'Boundi field in the Republic of Congo to feed two electricity generating plants in which it holds a 20% non-operating stake. As well as investing in the necessary infrastructure, Eni is training Congolese workers in Italy, helping to build local skills for the long term.

Third, companies can invest in research and development and bridge the gap between the laboratory and the market, developing new, renewable fuels and renewable generation technologies. Eni is a founding member of the MIT Energy Research initiative, supporting a wide range of energy

research projects from traditional hydrocarbons to methane hydrates to solar energy.

Fourth, they can promote trade in sustainable energy products. Total, for example, is leveraging its local financing and distribution networks to deliver its Awango line of solar lamps and points for mobile phone charging in Cameroon, Indonesia, Kenya and the Republic of Congo.

Finally, they can use their business expertise to create innovative ways to make energy more affordable and improve access to clean cooking and heating solutions. Products such as LPG offer particularly interesting opportunities for oil and gas companies. Shell, for example, is a founding partner in the Global Alliance for Clean Cookstoves, promoting the adoption of clean cookstoves and fuels in 100 million households by 2020.

The oil and gas industry is in a unique position to drive the partnerships and action needed to achieve sustainable energy for all by 2030, ending energy poverty while helping to curb climate change that could be devastating for rich and poor alike.

This is not just the right thing to do. As the old saying goes, you can do well by doing good.

UN Under-Secretary-General Dr Kandeh K. Yumkella is Special Representative of the UN Secretary-General for Sustainable Energy for All, and CEO of the SE4All initiative (www.se4all.org).



◀ An efficient alternative to solid fuels, switching to LPG also provides health, safety and environmental benefits.



Case study: Solutions to improve access to energy

Total is working in developing countries, including Myanmar and Burkina Faso, to bring energy solutions and business opportunities to low income populations.

By Jean-Marc Fontaine

Christophe de Margerie, the Chairman and CEO of Total from 2007 until 2014, said: "Energy is vital to human development. It boosts living standards, drives growth, and reduces poverty and illiteracy."

Because energy is vital it must be available to everyone. Total is committed to total access to energy. The company aims to do this by bringing innovative solutions dedicated to low income populations, developing viable business models, and relying on the group's initiatives.

► Providing access to energy where there is no grid is important to development.



The Total Access to Energy programme

This programme is an incubator for several projects.

- **Awango by Total** This programme markets innovative energy solutions dedicated to people in emerging countries without access to modern forms of energy. Offering solar kiosks is an extension of the Awango project and this is currently under study.
- **Fighting energy poverty** Total is developing energy solutions for OECD country customers for whom transport and heating needs are not being met.
- **Cooking stoves** Total is investigating ways to develop clean, safe cooking solutions.

- **Mini grids and gas** Prospective work by Total includes building a new business model for mini-grid projects and providing sustainable access to electricity to the neighbouring communities of some of the company's E&P sites through gas reuse.

The Awango programme

Awango is a social business with three targets. They are to:

- Deliver social, economic and environmental benefits to help spur on the development of emerging markets through sustainable access to energy.



◀ Demonstration of an "Awango by Total" solar kit in the village of Kaung Byan, Myanmar.



◀ Four sisters doing their homework in eastern Burkina Faso. Darkness no longer stands in the way of their education.

- Ensure economic viability in every link of the chain, as this is a cornerstone of sustainable business.
- Build strong partnerships to cope with complex local situations.

Awango aims to be an innovative, profitable and sustainable business model. An example of this is the eight-step cycle of a solar project.

- 1 Design and source quality solar products;
- 2 Supply chain and logistics optimisation;
- 3 Last Mile distribution;
- 4 Specific instruction and responsible marketing;
- 5 Efficient financing solutions for the people;
- 6 Customer feedback and evolution of the offer thanks to field surveys;
- 7 After-sales service and warranties for all the solar products.
- 8 Reinvestment of the profits for the growth of the project.

The solar products initiative achieves 60% of its sales through service stations and LPG resellers. The remaining 40% of sales are through independent resellers, young solar resellers, institutional

partners (such as cooperatives, NGOs and micro-finance providers), business-to-business clients (such as plantations and mines) and solar liaison officers at E&P operations.

An example of a highly successful solar product that is part of the Awango programme is the sale of solar lamps. Since the programme began in 2012 and up to September 2014, 750,000 solar lamps had been sold. The aim is to sell 1 million lamps by the end of 2015. The lamps are sold in 20 countries with plans to expand into a further nine.

As well as the 1 million lamps goal, the Total Access to Energy programme has other ambitions. Total aims to have the programme positively impact the lives of 50 million people by 2020, to further develop and promote its social business model, to have a positive impact on the climate-energy challenge, and to strengthen Total employees' pride in belonging to this group.

Jean-Marc Fontaine is the Vice President of Sustainable Development for Total (www.total.com).



◀ A student revising course notes while charging his phone with the aid of an Awango by Total lamp. It is hoped that over a million lamps will have been sold by the end of the year.

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Global Cooperation

- **Patrick Pouyanné, CEO of Total**, examines the upheavals and challenges which have affected the energy industry in the past year.
- **Abdalla Salem El-Badri, Secretary General of OPEC**, explains the international effort required by OPEC countries to overcome fuel poverty.
- **Maria van der Hoeven, Executive Director of the International Energy Agency (IEA)**, writes about mitigating climate change, energy security and ensuring adequate supply.
- **Besim Şişman, CEO of Turkish Petroleum**, offers his perspective about the future of the inter-connected global energy marketplace from Turkey's strategic geographical position.
- **Pedro Miras Salamanca, Chairman of CORES, Chairman of the Standing Group on Emergency Questions, International Energy Agency and Chairman of the Spanish National Committee of the World Petroleum Council**, writes on security of supply for hydrocarbon stocks in Spain.
- **Peter Gaw, Managing Director of Oil, Gas and Chemicals for Standard Chartered Bank** offers assurance that the bank financing model will continue to support the energy industry in a low oil price environment.
- **Jon Marsh Duesund, Senior Project Manager for Rystad Energy**, reflects on what a drop in oil prices means for Arctic projects.
- **Jorge Ciaciarelli, Executive Secretary of the Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean (ARPEL)**, charts the growth of the LNG sector across multiple markets.
- **Wanjiku Manyara, General Manager of the Petroleum Institute of East Africa** discusses the prospects for the vibrant and growing East African oil and gas industry.
- **Georgia Lewis, Managing Editor at International Systems and Communications Ltd**, gives an overview of the bright future that lies ahead for India's energy industry.
- **Ekaterina Grushevenko, Dimitri Grushevenko and Anna Galkina**, from the **Energy Research Institute of the Russian Academy of Sciences**, analyse the Russian energy industry's prospects.

Challenges facing the oil and gas industry in the coming decades

Changes in the energy industry over the past decade mean new approaches are needed to meet demand in the coming years.

By Patrick Pouyanné



Who would have thought in 2000 that 10 years later, thanks to the so-called shale revolution, the US would become self-sufficient in gas and the leading oil producer ahead of Saudi Arabia and Russia?

Who would have thought that the German “EnergieWende” and its tremendous push in favour of the development of renewable energies would translate (at least initially) into more CO₂ emissions in Germany?

More recently, who would have said in September of last year that four months later oil prices would fall below the \$50 mark?

The recent changes in the energy landscape have made it clear that strong and well established beliefs could be brought into question.

In an era of such major changes, players in the oil and gas industry have to stay the course and demonstrate an unprecedented level of flexibility and reactivity.

As a matter of fact, all energy phenomena are complex and have global repercussions. They are complex, because any minor change of even one parameter may have consequences on the whole picture. The German example is a clear illustration of this particular phenomenon. And they are global,

► New techniques for unlocking unconventional gas deposits will help to balance falling production from mature fields.



because these phenomena cannot be considered on a country by country basis. Issues such as access to resources, the nature of markets, price setting, technological development, core competencies, and geopolitical crises are all considerations and all these phenomena are global.

How, given this context, should we address the next 20 years?

Any global oil and gas company has to meet the following two targets at the same time: to satisfy the energy requirements of the world's growing population; and to contribute to the fight against climate change, which today is recognised as a major issue.

In other words, our mission is the following: to supply cleaner, safer and more affordable energy to the world's population.

Satisfying the energy requirements of a growing population

World energy demand is driven both by population growth and economic growth. Most experts agree that world population will reach 9 billion by 2040, compared to 7 billion today, with Africa alone accounting for 50% of the growth. World economic growth will average 3%-to-3.5% per year in the coming decades, with rates higher than 5% in Africa, Middle-East and Asia.

What does this mean for world energy demand?

Even with very ambitious energy efficiency targets, the world's energy demand will grow, according to the IEA's latest scenarios, at a rate between 0.5%-1.5% per year. In the "new policies" scenario, world energy demand could be around 35% higher in 2040 compared to today's levels (roughly 18 billion tonnes of oil equivalent compared to 13 billion in 2012).

Whatever the hypothesis, one thing seems to be clear: even if the share of renewable energies increases to between 19-30% of the total energy mix by 2040, fossil fuels will still represent a large proportion of the mix in the "new policies" scenario (26% for oil, 24% for gas and 24% for coal). In the less fossil fuel dependent scenario (the so called



"450 ppm" scenario, necessary to maintain the average increase of world temperature below 2°C), fossil fuels will account for 59% of the energy mix with 22% for gas, 21% for oil and 16% for coal.

Nevertheless, both these scenarios will require huge efforts from the oil and gas industry, of two different kinds. On the one hand, the oil and gas industry will have to invest huge amounts of cash (\$750 billion per year is mentioned) to develop new resources, in ever more complex conditions, to compensate for the decline of current producing fields. On the other hand, wind and solar will need to grow very fast (shares will be multiplied by five in the "new policies" scenario and by 10 in the "450 ppm" scenario).

It means that the oil and gas players need to dedicate sufficient resources to R&D and innovation. Additionally, this is an approach that today helps us to continuously improve our risk control.

▲ Germany's drive to develop renewable energy capacity actually saw the country's CO₂ emissions rise for a time.

► Focusing on improved energy efficiency across all sectors of the industry will decrease costs and environmental impact.



It will also allow us to develop new technologies, techniques to improve the oil recovery rate of existing fields (only 35% today), to develop new hydrocarbon resources in deep or ultra-deep offshore, or to develop shale gas, sour gas or Arctic gas, and all this while taking into account the reduction of our environmental footprint.

These R&D efforts will help the oil and gas industry to reduce its operating costs which saw an average rate of increase of around 14% per year between 2000 and 2013.

Last, they will allow the oil and gas industry to develop new profitable business models in renewable energies, particularly in solar.

Contributing to the fight against climate change

Let's face it – fossil fuels are responsible for roughly two thirds of CO₂ emissions in the world. Even if more than 40% of fossil emissions come from coal, oil and gas companies cannot ignore that they have to satisfy their customers' energy requirements with ever-decreasing levels of emissions.

This responsibility comes together with the energy mix evolution target and drives changes in

the way oil and gas companies do business. All actions need to complement each other.

First, we have to promote natural gas utilisation. Natural gas has the lowest emissions of the three fossil fuels (half that of coal); it definitely makes it the ideal choice for coal substitution in electrical power generation and the ideal complement to renewable energies.

Second, we have to be involved in the development of the most promising renewable energies, the ones that can be profitable without subsidies. This is already the case for solar energy in 17 countries around the world, due to significant improvements in cell yields and production costs. This type of technology seems to be particularly well suited to quickly provide energy to populations in remote regions.

Third, we have to implement comprehensive action plans to improve energy efficiency. This will reduce our production costs and our environmental footprint, through technological innovation and operational excellence in the upstream, refining and petrochemicals sectors. We also need to help our customers improve, and make more efficient, their own energy consumption by providing



◀ Solar power has seen significant improvements and can be profitable without subsidies.

them with more environmentally friendly products and solutions.

Fourth, we need to facilitate energy access for populations who don't enjoy it today. This is, for instance, what we do with our "Awango by Total" programme where we commercialise solar lamps in Africa and Asia. Today, we have sold around 1 million lamps, providing light to more than 5 million people.

Fifth and finally, we must engage even more in international initiatives like the UN Global Compact, the Climate and Clean Air Coalition and the World Bank. These international platforms provide an important framework for the actions the oil and gas industry can take in the fight against climate change. The idea is to share best practices and technical solutions to address climate change and sustainable energy issues, the main topics being the role of natural gas in the energy mix, energy efficiency, reduction of gas flaring, methane emissions and carbon pricing.

The necessity to fight climate change has been agreed upon, as has the list of the main actions to be taken in order to reduce greenhouse gas emissions. Because of its presence all over the world and

the nature of its activities and products, the oil and gas industry has a great responsibility to respond to these challenges. It cannot just be a follower in this matter. It has a major role to play.

In other words, the oil and gas companies have to transform the challenges they are faced with into opportunities. It should be part of their mission and they have to dedicate the necessary resources to succeed. This is a prerequisite if they want to be able to go on attracting investors and talents in the future.

The next 20 years will be pivotal for our industry. The challenges include adapting to the necessary changes to be able to develop our operations in an increasingly digitised world, the optimisation processes linked to "big data", and the development of an ever more connected global community. As a result, a new type of energy company will emerge, step by step. However, the number one mission of this new type of company will still be to supply increasingly cleaner, safer and more affordable energy to the world's population.

Patrick Pouyanné is the CEO of Total (www.total.com).

Sustainably energising the world

OPEC member countries will have to play a major role in overcoming energy poverty across the world.

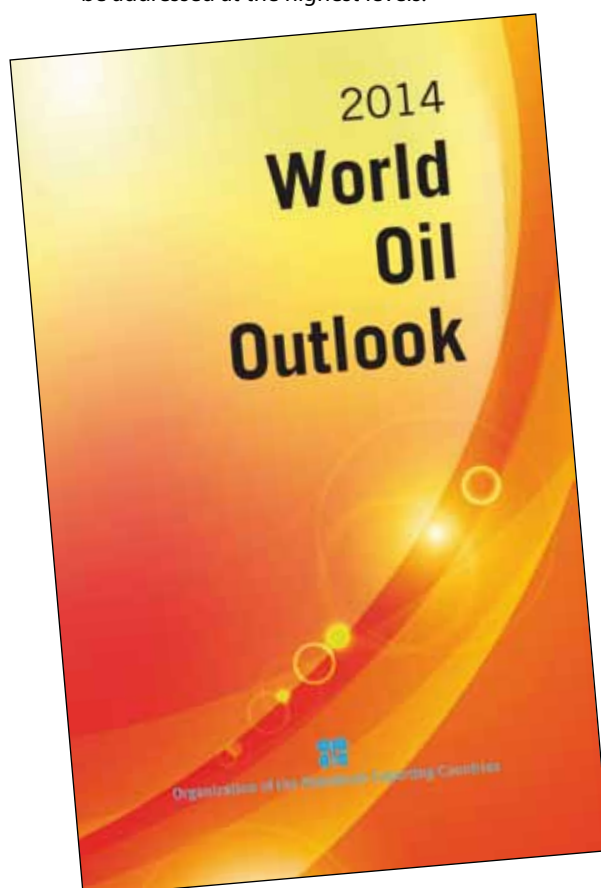
By Abdalla Salem El-Badri



Energy has been central to a great deal of the progress of humankind over the centuries. It has positively impacted the lives of billions in terms of providing light, power and mobility. And the history of the industrialised world has been built on the back of fossil fuels.

However, we should not forget that this has not been the story for all. For many billions of people across the world, starting a car engine, switching on a light or turning on a mobile phone is not something they have experienced. These everyday things, that many take for granted, are only a dream. The issue of energy poverty is something that needs to be addressed at the highest levels.

► OPEC's World Oil Outlook 2014 forecasts energy demand to rise by 60% in the next quarter century.



Today, around 2.7 billion people still rely on biomass for their basic needs, and 1.3 billion have no access to electricity. They need access to reliable, safe and secure modern energy services to live and prosper. Without this access, many will continue to suffer from health and environmental problems, and their economic opportunities will be limited. We need to remember that energy is recognised as an “enabler” of sustainable development.

It is extremely positive that Goal 7 of the UN's Sustainable Development Goals calls for nations to “ensure access to affordable, reliable, sustainable and modern energy for all”. Sustainable development is also a high priority for OPEC member countries. It is also the main goal of the financial and technical assistance these countries provide to other developing countries, whether directly through their own aid institutions or through their participation in the OPEC Fund for International Development (OFID).

Looking ahead, the world population will keep expanding. It is expected to reach almost 9 billion by 2040 – an increase of around 1.7 billion from today's level. And all these additional people will require access to modern energy services too.

So with more people on the planet, the need to provide more access to energy, and expanding economies, energy demand is set grow. In OPEC's World Oil Outlook 2014, between 2010 and 2040 we expect energy demand to rise by 60%.

With all this in mind, the basic challenge is twofold. Firstly, to supply enough energy to meet demand and help provide access to modern energy services for those currently without and those still to be born. Secondly, this needs to be done in a sustainable way, balancing the needs of people in



◀ While renewables, including large hydro, are expected to grow over the coming decades they will still form only a small proportion of the energy mix.

relation to economic situations, social welfare and the environment.

All energies required

It is clear that all forms of energy will be needed. But it is crucial to appreciate just what each energy source can offer to the future.

Renewables – from wind, solar, small hydro and geothermal – are expected to grow at more than 7% per year over the coming decades, often as a result of government support and incentives. They certainly hold promise, but globally their share of the energy mix will still only be 4% by 2040, given their low initial base.

The share of biomass, nuclear and large hydro is expected to remain at steady levels throughout the period 2010-to-2040, at around 9.5%, 5.5% and 2.5%, respectively.

Thus, it is fossil fuels that will continue to play the dominant role in meeting demand, although their overall share will fall from 82% to 78% during this period. Through the initial part of that projection period, oil is expected to continue to have the largest share of all energy types. But after 2030, the individual shares of the three fossil fuels – oil,

gas and coal – are seen converging towards similar levels of around 25-27%.

There are often questions asked about whether this kind of growth can actually be achieved. There is no doubt that it can.

In terms of oil, OPEC's projections see demand increasing by more than 20 million barrels a day during the period to 2040, with developing Asia accounting for most of the global increase. There are clearly plenty of available resources to meet this expanding oil demand.

Technological advances continue to help the industry increase the estimates of the amount of oil and gas that can be found and recovered, extending the reach into harsher and more remote "frontier areas". What was once described as "impossible oil" has today become possible.

Of course, having the resources available is only part of the story. To accompany this, oil and energy markets also need to be stable and predictable in order to help deliver and sustain our energy future. This represents a major test in itself.

Since June 2014, there has been much focus on the near-term market, falling oil prices, and the volatility and uncertainties for all stakeholders. This

► Since June last year short-term oil price uncertainty has captured the headlines, but a long-term view must be maintained.



is understandable, but it is also important to keep an eye on the long-term and the fact that the world will need more energy. What is clear is that more energy requires more investment. In OPEC's WOO 2014, oil-related investment requirements alone are estimated to be around \$10 trillion between now and 2040.

In looking ahead, there is no doubt that the path for the industry will be marked with challenges, just as it has been in the past. It is therefore vital to better understand some of the expected challenges, as well as opportunities, and identify areas where dialogue and cooperation among producers and consumers might help. At OPEC, we recognise the value of strong and mutually beneficial relationships.

Negotiating the challenges

Alongside the current oil market situation, the challenges for the industry include challenges that we can call "known uncertainties". These include the role of financial markets and oil market speculation; manpower bottlenecks; the energy-water nexus; energy policies in some consuming countries; and the potential impact of UN climate change

negotiations. And there are also "unknown uncertainties". These are most often related to geopolitics and severe weather patterns.

At the end of the previous decade and in the early years of this one, the impact of the increased financialisation of oil markets was much discussed as some price movements were clearly not being driven by fundamentals or the normal ebbs and flows of the market. They were being driven by market speculation.

There is also no doubt that speculation played a role in the oil price dropping by more than 60% between June 2014 and January 2015. The actual supply and demand fundamentals of the market did not warrant such a fall.

It is extremely important to keep a watchful eye over speculative activities. With this in mind, earlier this year the International Energy Agency (IEA), the International Energy Forum (IEF) and OPEC organised the 5th joint workshop on the Interactions between Physical and Financial Energy Markets.

It is clear we cannot avoid speculation and volatility altogether. But extreme price fluctuations are clearly not conducive to the effective function-

ing of the market, particularly given the long-term nature of investments in our industry.

The goal for both producers and consumers must be a stable price. It is a price that helps to deliver the necessary investments – and here we need to remember the cost of the marginal barrel – that allows producers to receive a reasonable income, and that enables the global economy to grow.

There is the human resource challenge. With strong competition from other economic sectors for skilled workers, there is a need to address the oil industry's difficulties in finding and hiring labour at the global level. The industry needs to make sure it is attractive to prospective graduates, retains talented people and transfers knowledge to the next generation. They will be the ones that push the industry's boundaries in the years ahead.

In 2013, the European Union and OPEC conducted a study and held a roundtable on potential manpower bottlenecks in the petroleum industry to consider this challenge in greater detail.

There is also the energy-water nexus. It is important that we better understand the links between energy and water. Both are vital to economic development and human well-being, and scarcity in one will likely affect the availability of the other.

For producers, it is also important to have a better understanding of the environmental and energy policies of consuming countries.

Obviously, every country has the sovereign right to set its own policies. But it is essential that they provide a clear idea as to the potential impact of policies on future oil consumption levels, as well as overall energy supply and demand patterns.

At the heart of this is security of demand. This is just as important to producers, as security of supply is to consumers.

Energy security should be viewed as a full circle. Producers do not want to waste precious financial resources on infrastructure that might not be needed, particularly given the scale of the required investments. At the same time, however, if timely and adequate investments are not made, then future consumer needs might not be met.

And there is also the challenge of climate change and protecting the environment. We cannot pretend that climate change is not a serious issue. There is no doubt that it is. It impacts us all. But we also cannot pretend that renewables are the only solution, or that they are available at scale today. Nor can we pretend that climate change is the primary concern for the billions who remain without modern energy services. We need a balanced approach and debate, one that takes into account the diversity of needs and viewpoints.

OPEC member countries have positively and constructively engaged in the UN climate change negotiations. They recognise the importance of keeping in mind the three pillars of sustainable development: economic growth, social progress and environmental protection.

Dialogue with all

When talk turns to a sustainable energy future, it is vital to make sure all voices are heard. We all want a secure, stable and sustainable energy future, but this means different things to different people and, specifically, we need to recognise the importance of alleviating energy poverty.

At OPEC, we see that many of the energy challenges we face are best confronted together. Dialogue and cooperation have long been watchwords for OPEC. Over the years, we have evolved and strengthened our dialogue with organisations and countries such as IEA, IEF, the European Union, the Russian Federation and the G20.

Such dialogue and cooperation are essential elements in our ongoing efforts to maintain stability and confidence in the industry. Those of us who are in the energy business have a responsibility to engage in such activities, and to do everything we can to enhance the security, stability and sustainability of an energy system that is essential to all of us.

Abdalla Salem El-Badri is the Secretary General of the Organisation of the Petroleum Exporting Countries (www.opec.org).

Security of supply and meeting demand on a global level

Mitigating climate change adds new urgency to ensuring long-term energy security.

By Maria van der Hoeven



The world has changed dramatically since the founding of the International Energy Agency (IEA). New players are providing energy supplies, evolving technologies are allowing a more diverse fuel mix, and while IEA members once accounted for around three-quarters of global demand, they now account for less than half. Perhaps most fundamentally, almost all decisions on energy, including on supply security, must now be viewed through the lens of climate change. Indeed, energy security and climate are intimately linked.

There is no longer any doubt that our energy system is contributing to climate change. Yet what

goes around comes around: the changes in climate resulting in part from our dependence on fossil fuels will cause hardship for the global energy system in the decades ahead. We have been painfully reminded of this fact too often in the past few years with major weather events that, in addition to leading to tragic loss of life, have caused major damage to critical energy infrastructure.

In the midst of growing concern over this overarching threat to our environment, economies, and expected standard of living, our global energy system is going through its own period of adjustment. Just as the weather can turn from calm to storm in

► Surveying the aftermath of Hurricane Ike in Biloxi, Mississippi. Extreme weather events remind us of the powerful effects of the world's climate.



a heartbeat, the oil market can shift dramatically with little or no warning. This was a headline energy story of 2014, with oil prices plunging to five-year lows. This drop has led many to question the changing dynamics of the market, the inevitable knock-on effects to energy security and future progress on meeting climate targets.

What we are seeing is that the oil market of tomorrow looks different from the market of yesterday; both demand and supply patterns have shifted. By unlocking light, tight oil (LTO) – a vast resource that long seemed off-limits – the US has changed the rules of the game and effectively become a new swing producer. Oil supply from outside of OPEC is becoming far more price-elastic than in the past, while demand becomes significantly less so.

Weak demand should come as no surprise. For one thing, the world economy remains relatively weak itself. This is part of the reason prices fell in the first place, and makes it less likely that lower prices will, in and of themselves, fuel a large increase in demand. This is not to say that demand growth will not gain momentum as the global economy slowly improves. But it will do so more slowly than had been expected, in line with the IMF forecast of underlying economic growth.

Tackling subsidies

There are, of course, quite a few economic benefits to be expected from lower prices, including higher household disposable income, and lower industry production costs. However, these benefits may be partly offset by deflation in some of the largest OECD economies. Outside of the OECD, weakening currencies mean that lower prices in US dollars will not necessarily seem that much lower to end users in domestic currencies. This will be compounded by the fact that many governments are rightfully seizing the opportunity of lower prices to dismantle their costly and ineffective subsidy programmes.

Rightfully, because low oil prices represent an opportunity to make smart decisions on subsidies, specifically those that result in prices paid by end users being reduced to below international bench-



marks. For example, in Saudi Arabia, gasoline prices at the pump are one-eighth of what they are in London. These are known as fossil-fuel consumption subsidies, and are an extremely inefficient means of achieving their stated objective, which is typically to help the poor.

In 2013, governments around the world spent \$550 billion on such fossil-fuel consumption subsidies. This is more than five times the level of support that went to renewable energy. It is also twice as much as actual investment into renewables in 2014.

Ten countries account for almost three-quarters of this \$550 billion, and five of them are in the Middle East and North Africa. In fact, more than one-third of electricity in the Middle East is generated using subsidised oil. In the absence of these subsidies, almost all renewable energy technologies, including nuclear, would be competitive with oil-fired power plants.

And indeed in 2014 we saw significant initiatives to tackle subsidies in Jordan, Morocco and Egypt. Jordan removed fossil fuel subsidies early last year and raised electricity prices the following summer. Morocco has been reducing subsidies progressively on diesel and gasoline since the beginning of 2014. Egypt has raised the price of residential gas supplies, gasoline and diesel. This could reduce Egypt's subsidy bill by about one third – that's \$5 billion.

▲ In the absence of fossil fuel subsidies renewable energy production would be competitive with oil-fired power plants.



These are wise and prudent measures to be taken, especially at a time when the future of oil supply in the Middle East and across OPEC is being questioned. In fact, despite OPEC's stated policy of defending market share, it is only expected to contribute roughly one-third of global capacity growth to 2020. It will succeed in regaining a larger market share in terms of global supply, but only up to a point. OPEC's share of global production will grow, but it will not revisit the higher levels reached before the financial crisis of 2008.

Of course this assumes that everything goes right with OPEC production, and this is perhaps a risky assumption. If international sanctions on Iran remain in place, nearly 90% of OPEC capacity growth through 2020 will come from a single country, Iraq. The list of challenges facing this country grew longer last year with the campaign waged by the self-styled Islamic State and the price collapse. But this has yet to derail its medium-term production outlook. As recently as December 2014, Iraq's production surged to a monthly average of 3.7 million barrels per day, a 35-year high.

Iraq is a good example of how the effects of low prices can be doubled-edged. On the one hand, the price drop makes production more difficult to finance and less profitable. On the other hand, it is an incentive to raise production volumes to make up for the loss of revenue, and to quickly resolve problems that had been holding down production.

The outlook for other OPEC countries looks dimmer. Venezuela and Nigeria will both feel the impact of low prices, leading to tighter budgets and cuts in social spending. Gulf countries may also miss their economic targets, though they have the advantage of higher buffers. Countries such as Angola and Ecuador face serious difficulty.

Outside of OPEC, Russia will be hit particularly hard. Its conventional production faces a perfect storm of collapsing prices, international sanctions, and currency depreciation; the country will likely emerge as the industry's top loser with production set to contract by 560,000 barrels per day over the period 2014-2020. Unfortunately the knock-on

effects from Russia's struggles could be significant for a number of countries in the region.

It's clear that low oil prices aren't good news for everyone, and of course there will always be winners and losers in a global market. This is the nature of relying on the import and export of a limited resource. There is no way for any country, no matter how secure it may be in terms of energy supply, to insulate itself from the challenges and shocks confronting neighbours near and far. This is because one of the greatest threats to energy security in the 21st century does not come from security of supply in terms of the market, but the greater, more existential threat of climate change.

Energy security

The evolution in thinking on energy security is reflected in the evolving mandate of IEA, where energy security now also encompasses sustainability. After all, an energy system that is not sustainable is, by definition, not secure. While oil producers may have once tried to avoid addressing the issue of climate change, they no longer have this luxury, for, as it stands, our world's energy system is not sustainable.

If we continue with business as usual, the planet is on track to become warmer, and not by the maximum 2°C that world leaders have pledged, but by around 6°C. This coming year provides a tremendous opportunity for world leaders to show vision and initiative by bringing real, measurable and effective climate targets to COP 21 in Paris in December 2015. These targets must take into account the energy system, because there is no longer any doubt that our energy system is contributing to climate change.

Users and producers across the entire fuel mix, including oil, must be a part of the conversation, and the solutions that are developed must involve the entire fuel mix. Calling for an immediate end to fossil-fuel use is just as short-sighted as claiming that climate change isn't happening. Innovation, in the form of energy efficiency, advanced biofuels, or carbon capture and storage, combined with a bal-



anced approach to the fuel mix, is the only reasonable way to meet climate targets while maintaining economic growth and providing access to energy for the hundreds of millions who currently go without.

Yet the nexus of climate and energy does not end at reducing emissions. Increased air and water temperatures, decreased availability of fresh water and increasingly intensive and frequent storm events and rising sea levels have disrupted and will continue to disrupt energy systems. These impacts do not exist solely in climate models or simulations. Already, we have seen instances of oil and gas production being halted, power generation being curtailed and energy infrastructure destroyed by hurricanes and floods. Energy security in the coming century will be more and more concerned with resilience.

It is this combined action on both mitigation and adaptation that will be necessary to ensure sustainable, affordable, and secure energy supply for years to come. This is of concern to every country and region, whether a country is a net importer or exporter, has stagnating energy demand or rapid growth, or features vulnerable coastlines or desertification.

It is clear that lessons have already been learned in this regard, for example with the US Secretary of

Energy's decision to create the one-million-barrel emergency stock of gasoline in the north-east region of the United States following Tropical Storm Sandy.

Unfortunately, this won't be the last difficult lesson, and weather event threats to energy security may increasingly find their way into the headlines. We can hope that world leaders will take note, and make 2015 a year that is remembered not simply as the year that the United States became an oil swing producer, but as the year that the world stood up and said that action on climate change must be taken now. Whatever action is taken, energy security must be taken into account, for the energy-climate nexus is central to the sustainability of our economies and standards of living.

Just as we cannot predict whether it will rain or shine one year from today, we cannot predict what the exact price of oil will be in one, two, or five years. However, long-term climate trends, and medium-term market trends, can be forecast. It is up to world leaders to take prudent, yet decisive, action based on such forecasts to ensure the future of energy security for not only individual countries, but for entire regions and the world.

Maria van der Hoeven is Executive Director of the International Energy Agency (www.iea.org).

▲ Carbon capture and storage technologies like those being developed at the CO₂ Technology Centre Mongstad will help meet climate targets and growing energy demand.



Energy for all

Turkey, which will host the 22nd World Petroleum Congress in 2017, is an important transit country for oil and gas and a regional energy hub.

By Besim Şişman



▲ Besim Şişman:
Turkey's geostrategic
advantage makes it a
natural energy bridge.

Have you ever heard of *Ex Oriente Lux*? This time-honoured phrase means "Light from the East" and refers to the Oriental Renaissance and the vital role of Eastern wisdom in constructing Western civilisation. Not only has the East left an indelible impression on Western enlightenment, but it has also aided commercial and industrial development of the West with its natural resources. East and West have been inextricably intertwined in the long run and a hybrid human civilisation based on technology and innovation has emerged.

Has the idea of *Ex Oriente Lux* lost its allure today? Not entirely but partly. We are living in an interconnected and polycentric world where borders are invisible and countries are more interdependent than ever before.

Energy is a *sine qua non* for sustainability of this hybrid and advanced human civilisation. Countries are increasing strategic cooperation and building multinational partnerships to come up with common solutions to address global energy problems. Turkey is making a major contribution to the goal of improving access to energy by using its gift from God: geography.

Turkey's geostrategic advantage, located between major source countries and consumer markets, has given it an important role as a natural energy bridge and makes it a key country in ensuring energy security and diversification of supply sources and routes. Turkey's geographic position as an intercontinental crossroads, financial and political stability and economic alternative pipeline routes strengthen the country's hand as an important transit country on the Eurasia energy axis and as a regional energy hub.

Moreover, the completion of numerous giant energy projects planned to pass through Turkey for

the purpose of delivering Caspian, Russian, Central Asian, Middle Eastern and Mediterranean oil and gas reserves to global markets will lay more emphasis on Turkey's energy corridor and terminal role.

Window of opportunity for growth

With a rapidly growing economy, Turkey's energy demand is increasing dramatically. According to the US Energy Information Administration, energy demand in Turkey will continue to grow at an annual rate of around 4.5% from 2015 to 2030, roughly a two-fold increase over the next decade.

Turkey's burning ambition to be among the top 10 global economies by 2023 necessitates meeting the country's craving for energy. However, with limited domestic proven hydrocarbon reserves, Turkey has to import nearly 90% of its oil demand and 97% of its gas demand.

At first glance, even though they are perceived to bring about some disadvantages, efforts to diminish Turkey's energy dependency will also come with great opportunities. Turkey's extreme vulnerability to external sources and inadequate domestic hydrocarbon resources make it imperative for Turkish companies to seek overseas investment opportunities.

With 60 years of experience, Turkish Petroleum (TP) is operating today in eight countries: Afghanistan, Azerbaijan, the Turkish Republic of Northern Cyprus, Iraq, Libya, Kyrgyzstan, Russia and Turkey. TP is committed to becoming a more active player in Turkey's international energy politics and meeting Turkey's energy needs through the development of domestic and international resources. An increase in the company's total stake to 19% in the Shah Deniz project and a share acquisition in Russia are the first signs of TP's dogged determination to grow aggressively in the global arena. TP has also

been continuing to develop business portfolios in hydrocarbon-rich regions such as the Caspian, Middle East, Russia, Africa and Latin America.

Technological transformation

New revolutionary technologies have transformed the hydrocarbon sector, leading to a dramatic increase in reserves and supply. Today we have more high-quality information that enables us to discover hard-to-reach fields both offshore and onshore and go beyond what is expected.

With new technologies, old fields, once thought to be depleted, have been re-evaluated and unconventional areas have come into prominence. In line with sectoral dynamics and trends, TP is branching out into a wider business portfolio involving unconventional resources, natural gas storage, deep sea exploration and pipeline transportation.

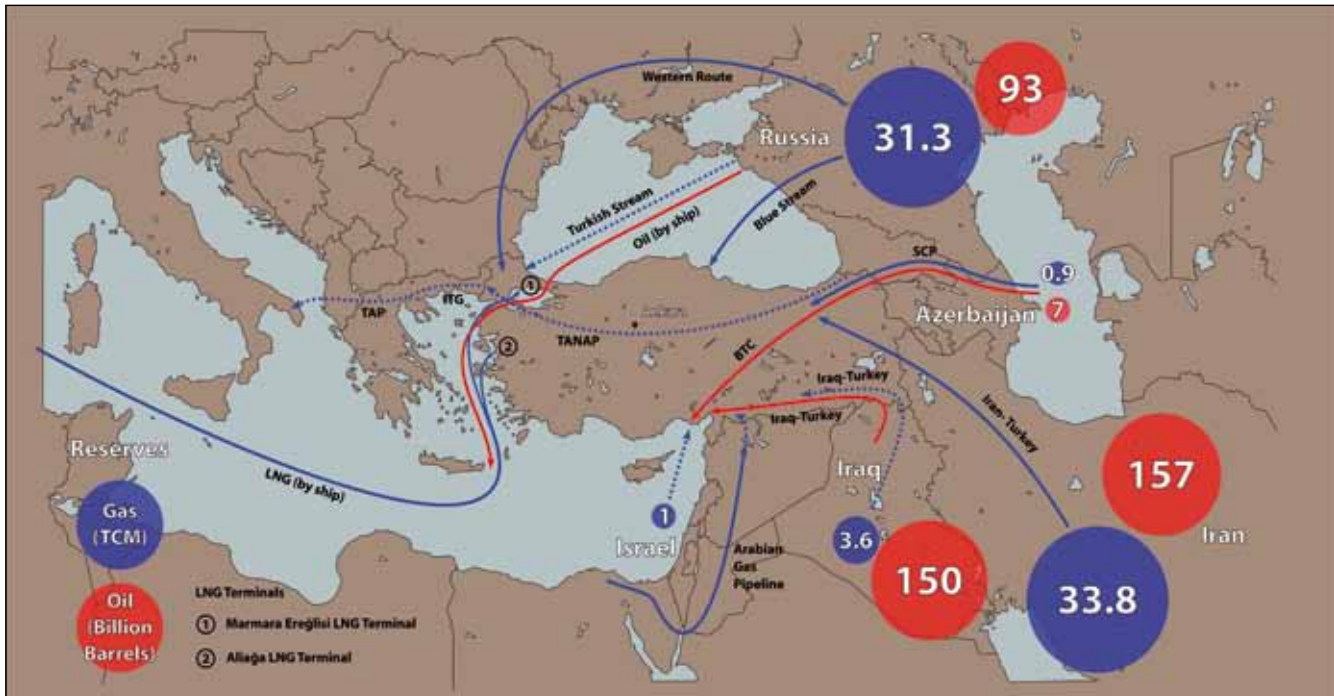
TP is moving away from its conventional fields of activity into unconventional fields, specifically centred on Thrace and south-eastern Anatolia. According to a recent IEA report, Turkey has a production potential of 3,800 million boe of shale oil and gas, indicating that this area deserves much serious atten-

tion. TP has signed a partnership agreement with Shell on the exploration of shale gas in the south-eastern part of Anatolia and the results are promising. TP has also agreed to cooperate with Halliburton in the development of Turkey's high unconventional potential. Unconventional sources would be a means of meeting a considerable amount of Turkey's energy demand and TP is focusing on several unexplored unconventional reservoirs in different regions of Turkey such as the eastern Anatolia, Black Sea, Salt Lake and Taurus basins.

For some time, TP has been carrying out deep-water exploration activities in the Black Sea and Mediterranean to assess offshore resources. With most of the licences in the Mediterranean Sea, approximately 150,000km², TP is seeking international cooperation to realise the region's high potential. TP has worked with Petrobras, ExxonMobil, Shell, BP and Chevron, and acquired useful data for the Black Sea hydrocarbon potential. The studies show that the Black Sea, which has a total area of 436,400km² and 40% of which belongs to Turkey, has a working oil system in the east and a working gas system in the west.



◀◀ With 60 years of experience, Turkish Petroleum operates in eight countries.



▲ Turkey's geographical location makes the country a pivotal player in the Eurasian energy field.

TP is also engaged in natural gas storage activities that eliminate seasonal risks stemming from variable external gas supplies and thus enable improved national energy supply security. Upon the completion of the development projects by 2019, TP will be able to store 4.3 billion cubic metres of gas, which is about 10% of Turkey's annual consumption. Natural gas storage facilities are TP's most profitable investments. When Turkey's increasing gas need is considered, an estimated two-fold increase by 2030, new facility investments are whetting domestic and foreign investors' appetites.

TP is closely studying how innovation and state-of-the-art technology in the oil and gas sector can help maximise its business productivity, and has developed strategic contacts with leading research centres and universities.

Turkey's energy policy attaches great importance to planning and financing, in coordination with neighbours and the international community, the required infrastructure for pipelines to transfer the region's natural resources to international markets. With shares of the Baku-Tbilisi-Ceyhan main export crude oil pipeline (BTC) and South Caucasus natural gas pipeline (SCP), TP has a strong desire to share its

experience and knowledge of new pipeline projects to make Turkey a regional energy hub. This role will be reinforced upon the completion of TANAP, TAP, Turkish Stream and other planned pipelines.

As an energy hub, Turkey's policy is to contribute to the establishment of peace, reconciliation and stability, and an environment of confidence and good neighbourly relations in this strategically important region.

Turkey: energy melting pot

Turkey's geographical location at the crossroads of Europe, the Middle East and the Caspian region with their enormous energy resources, makes the country one of the most pivotal players in the Eurasian energy field. Turkey is an energy melting pot for the South Caucasus, Central Asia, Middle East, Mediterranean and Russia with Europe and beyond. Turkey, a window to the world, is offering countless opportunities to you and your business. The energy heartland of the world is beating in Turkey.

Besim Şişman is the CEO and President of the Board of Turkish Petroleum Corporation (www.tpao.gov.tr).



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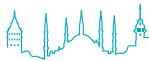
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Maintaining strategic reserves as a guarantee of security of supply

Spain is among the nations well placed to ensure hydrocarbon stock levels are well controlled.

By Pedro Miras
Salamanca



For more than 40 years, security of supply has been a central topic in energy debate among hydrocarbon importing countries. The issue has particular relevance in Spain, given that the level of self-sufficiency in both oil and natural gas is below 1%. The Corporación de Reservas Estratégicas de Productos Petrolíferos (CORES) is the central stockholding entity in Spain with responsibility for ensuring the security of hydrocarbon supply via the maintenance of strategic reserves of petroleum products and strict control of stock levels by the industry.

In 1974, the International Energy Agency (IEA), an independent body within the Organisation for Economic Cooperation and Development (OECD), was formed with the objective of ensuring the security of energy supply. It should be remembered that in the early 1970s, 72% of worldwide demand for crude oil came from OECD members, while OPEC supplied that market with 50% of global crude oil production. Against the background of

this profound imbalance between supply and demand, the IEA was formed in direct response to the oil crisis of 1973 which followed the interruption in supply declared by OPEC.

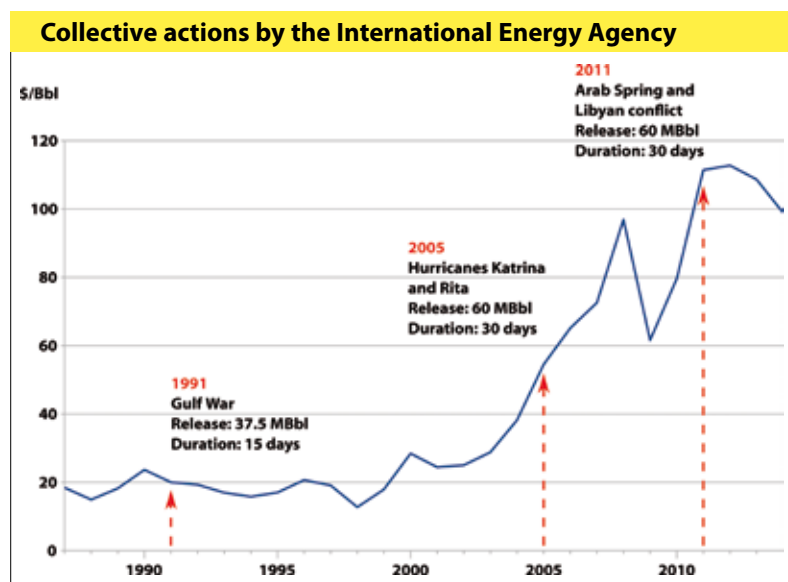
While Spain has been a member of the IEA since its inception, the European Union initially joined as an observer. Membership of the IEA implies adherence to the Agreement on an International Energy Programme, a policy by which the 29 member states actively commit to maintaining stocks of crude oil equivalent to 90 days' net imports, along with the implementation of joint action in the event of an interruption or scarcity of supply. These measures may be undertaken from either a supply or demand angle, ranging from employing oil reserves to the restriction of demand or the use of other fuel sources.

Over the course of its history, the IEA has activated its emergency procedures three times due to major interruptions in supply: during the first Gulf War in 1991; following the effects of Hurricanes Katrina and Rita in 2005; and during the 2011 civil conflict in Libya.

In 1991, in the wake of the Gulf War, the IEA implemented a contingency plan for 2.5 million barrels per day over 15 days, most of which came from a release of stocks.

The second intervention occurred in 2005, following the devastating effects of hurricanes Katrina and Rita, which destroyed practically the entire petroleum industry infrastructure around the Gulf of Mexico. The 26 IEA member states at the time joined forces to release the equivalent of 60 million barrels onto the market (2 million barrels a day for 30 days), through a combination of emergency response measures involving the use of sec-

▼ Figure 1.



urity reserves, increasing their own production and restricting demand.

The last release of reserves took place in June 2011, when maximum seasonal demand coincided with the interruption of crude oil supply from Libya which was in the midst of civil war. On this occasion, 60 million barrels were released from the strategic reserves of eight member countries of the IEA, equivalent to 2 million barrels per day for a period of 30 days.

The IEA now actively promotes cooperation with non-member countries thanks to its major influence within the energy market. Since its inception, the IEA has had ties with non-member countries, both producers and consumers. These processes have accelerated over recent years, as a result of a percentage reduction in the relative share of the IEA in the worldwide energy panorama. Cooperation with non-member countries, such as Brazil, China, India, Indonesia, Mexico, Russia and South Africa, covers a wide range of activities, from working groups, studies and surveys, through to a consultancy role in preparation for possible future interruptions to supply.

The IEA also works closely with other organisations and international forums within the energy field. It plays an active role in debates with OPEC and other oil producing nations, particularly at the International Energy Forum (IEF), an organisation comprising 76 member countries representing around 90% of the global supply and demand of petroleum and gas products.

This commitment to non-member countries and other international organisations is an integral part of the IEA's efforts to ensure that the various interest groups share a genuinely global vision of the worldwide energy system.

The EU and the IEA working together

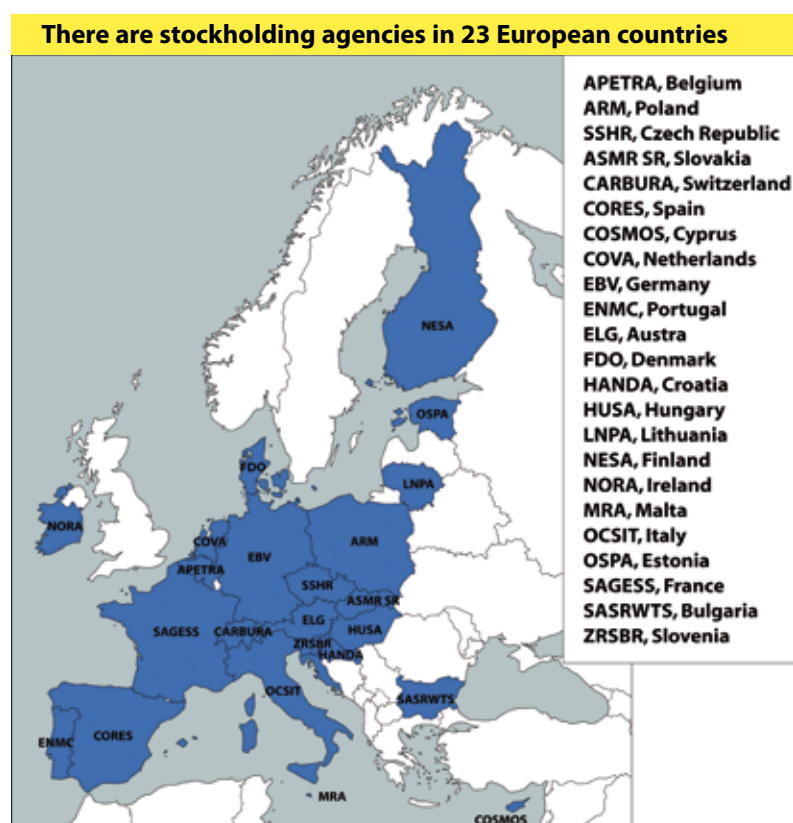
The European Union is also involved with the IEA, administering the majority of the strategic hydrocarbon reserves of European countries through its various agencies. Since its constitution, the EU has formed part of the IEA and by means of the Council Directive 2009/119/EC, has imposed a

fixed minimum obligation to maintain reserves of petroleum products, at levels of 90 days of average daily net imports and 61 days of average daily inland consumption.

Under the terms of this directive, countries may establish a central stockholding entity. This is an agency which can either control all reserves itself or share the responsibility with the industry. The directive considered this system to be the most efficient way of maintaining and managing reserves from operational, financial and security of supply perspectives.

The combined system of dividing reserves between the agency and the industry presents a number of advantages. On the one hand, it allows greater control of the reserves as these are located within a single entity. On the other hand, it externalises industry debt as it is not forced to maintain all emergency stocks. This solution also reduces the financial costs as the agency has greater access to credit, and provides improved flexibility when release of fuel for consumption becomes necessary.

▼ Figure 2.





▲ Crude oil storage at the Port of Barcelona. Dividing responsibility for strategic reserves between government agencies and industry can be advantageous in a number of ways.

As a result, there has been a proliferation of stockholding agencies throughout Europe over recent years. They now exist in 22 of the 28 EU member states, including Spain, as well as in Switzerland (see Figure 2).

The role of CORES in Spain

CORES, which is the central stockholding entity in Spain, plays a vital role in the hydrocarbon sector, working to ensure security of supply at all times. Spain has a combined security of supply system, in which responsibility for maintaining hydrocarbon stocks is shared between CORES and the oil and gas industry.

CORES was established in 1995, as part of a process of liberalising the Spanish petroleum sector. Its principal mission was to constitute, maintain and manage strategic reserves of oil products and control the minimum security stocks held by the industry. CORES was constituted as a non-profit Public Law Corporation, operating under private law. Its governing board includes representatives appointed by the Ministry of Industry, Energy and Tourism as well as the petroleum and natural gas sectors. In December 2013, CORES was appointed the central stockholding entity in Spain.

The objective of CORES is to ensure the continued security of supply in Spain. Of the 92 days' minimum level of petroleum stocks which must be maintained, 50 are held by CORES, with the remaining 42 days' worth in the hands of the industry. In addition, there is an obligation to maintain 20

days' consumption of liquefied petroleum gas (LPG) and a 20-day supply of natural gas, both of which are maintained by the industry (see Figure 3). One of the main roles of CORES is to monitor compliance by the industry with its stock reserve obligations.

In the event of a supply crisis, whether national or international, CORES will coordinate the release for consumption of the necessary stocks under the supervision of the Ministry of Industry, Energy and Tourism. During the last IEA collective action in June 2011, CORES oversaw the release of 2.3 days' worth of the reserves of petroleum products in the hands of the industry, and restored its obligation of 50 days' stocks within a year.

The privileged position of Spain

The Spanish system of security of supply has a high international profile. Spanish and EU regulations envisage the possibility of maintaining reserves of crude oil and petroleum products in other countries. In fact, this option has been actively encouraged since the Directive 2009/119/EC, to allow the calculation of reserves held in any of the member states. With this in mind, Spain has signed bilateral agreements on minimum security stocks with France, Italy, Ireland, Portugal, Malta and New Zealand, with the last two cases reserved for countries specifically permitted to store part of their strategic reserves in Spain.

Spain enjoys a privileged geographical position for the hydrocarbons sector, with access to the principal European markets (north-west Europe and the Mediterranean) as well as the Americas and the Middle East. In addition, the Spanish logistics system for petroleum products is one of the most transparent, accessible, flexible and efficient in the world. Spain has nine refineries, more than 4,000km of oil pipelines and 42 logistics companies. These 42 companies have 138 storage installations with a total capacity of 14,976 km³. The prices and conditions of the logistics system are publically available via the website of the National Markets and Competition Commission (Comisión Nacional de los Mercados y la Competencia).

In March 2011, the IEA congratulated Spain on its “highly impressive logistic network of oil pipelines and storage facilities”. All of these factors have combined to make Spain a preferred location for the reserves of other states and organisations which are attracted by the advantages on offer.

Maintaining natural gas stocks across the EU

Spain is committed to maintaining stocks of natural gas. The importance of petroleum in worldwide energy consumption has declined considerably over the last few years. According to the US Energy Information Administration, 45% of the world’s total energy consumption was from petroleum in 1980. The 2014 BP Statistical Review showed that this had dropped to 33% by 2013. Both coal and natural gas have increased their share in the worldwide energy consumption mix, representing 30% and 24% respectively in 2013, compared with 27% and 19% in 1980.

In the case of the EU, natural gas occupies second position as the source of primary energy, with 24% of the 2013 total, only exceeded by petroleum at 36%. In spite of this growing significance, natural gas is still largely overlooked in international security of supply policies.

Following the winter of 2009, when the supply of Russian gas to Ukraine was cut off, the EU issued “Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply”, on which open consultation closed in March 2015. However, this failed to include measures for the creation of emergency reserves of natural gas. As a result, only a few countries maintain such reserves, and Spain is one of them.

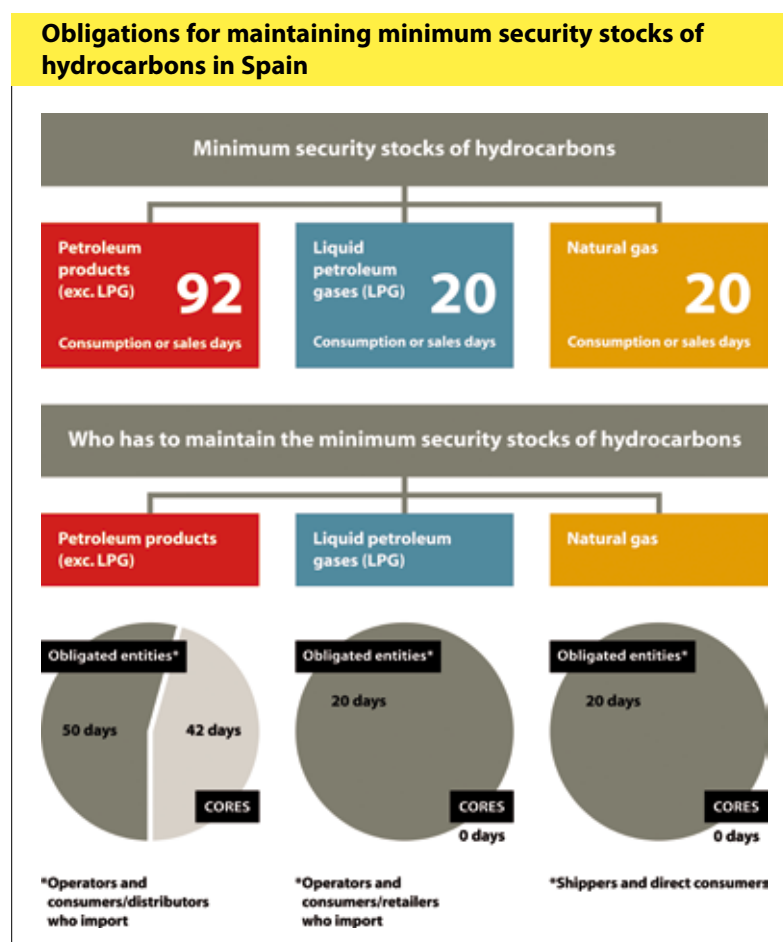
Natural gas suppliers in Spain are required to maintain 20 days’ worth of stocks, with CORES overseeing compliance with this regulation. In addition, CORES also acts to guarantee an adequate diversification of natural gas supply, ensuring that stocks from any single country of origin do not exceed the percentage specified under Spanish legislation, which is currently 50%.

Energy security in the long term

Security of supply is expected to become the central theme within the energy debate over the coming years. As we have seen in the course of this article, security of supply has been a major issue over recent years and will remain as such well into the future. The IEA will continue to monitor geopolitical events, acting as necessary and advancing their cooperation with non-member countries. In the case of Spain, CORES will carry on its work to ensure the security of supply of hydrocarbons, relying on the Spanish logistical system, which without doubt will continue to be one of the best in the world.

Pedro Miras Salamanca is Chairman of CORES, Chairman of the Standing Group on Emergency Questions (SEQ) of the International Energy Agency and Chairman of the Spanish National Committee of the World Petroleum Council (www.cores.es).

▼ Figure 3.



Bank financing in a low oil price environment

While prices have dropped sharply, there is reason to be optimistic about the oil and gas industry making a solid recovery.

By Peter Gaw



What goes up must come down. The oil and gas industry is once again experiencing a precipitous downward turn in the commodity price cycle. Low crude oil prices have caused a fundamental change in the financing of oil and gas companies and projects by banks. When compared year on year, there have been changes to financing factors such as institutional lenders' capital allocation to the energy sector, lenders' price decks, credit approval processes and structure of debt facilities.

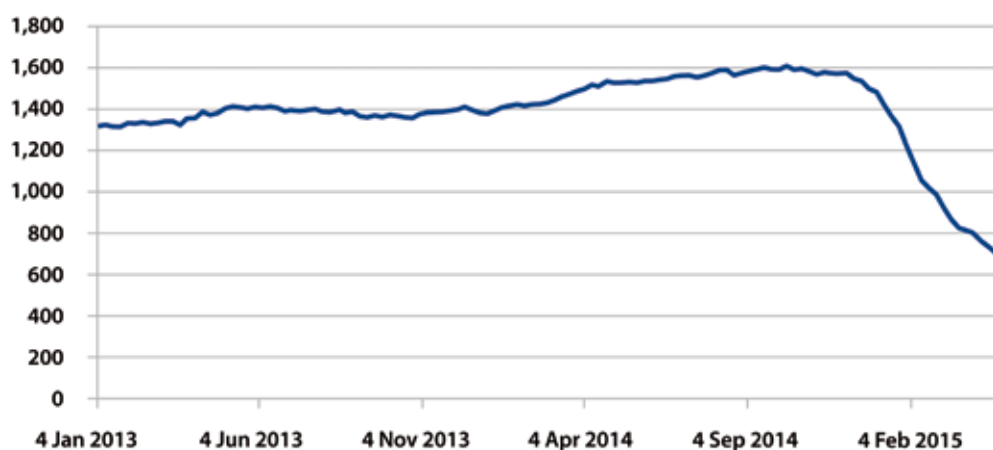
For context, crude oil prices declined sharply by over 45% in less than a year with Brent prices falling from over \$100 per barrel (/bbl) in August 2014 to approximately \$55/bbl by March 2015. This drop in prices has been driven by a combination of supply and demand dynamics. The extraordinary success of US unconventional exploration and production

(E&P) transformed the oil and gas industry, pushing up US production to c.8.7 mmbpd in 2014, the highest level in four decades, reducing US dependency on crude oil imports and contributing to total non-OPEC production growth of 2.2 mmbpd. Global supply of crude oil was further impacted by a surge in Libyan production in October, 2014 to 900k boepd from c.230k boepd in May 2014. Global oil production as at Q4, 2014 of c.95 mmbpd outstripped global demand of 94 mmbpd.

The stance taken by OPEC, led by Saudi Arabia, to maintain existing levels of production despite the fall in crude oil prices put further downward pressure on prices. Lower than expected demand caused by a slowdown in the macroeconomic growth of China and a prolonged emergence from the global recession in Europe further exacerbated the decline

► Falling crude oil prices have had a fundamental effect on financing for oil and gas projects.



US oil rig count

Source: Baker Hughes

◀ Figure 1.

in oil prices. The strengthening of the dollar and speculative trading increased volatility. The sudden return of crude oil price volatility after three years of oil prices over \$100/bbl forced many banks and financial institutions to reassess their institutional financing appetite for the oil and gas industry.

In Q1, 2015, the value of total global oil and gas bank financings, estimated to be in the region of \$94 billion, was down 37% from the previous quarter as prolonged price volatility affected access to credit for energy companies. By March 2015, the number of companies on Moody's B3 Negative and

Lower Corporate Ratings List rose to 184, up 6% from the previous quarter and up 26% from March 2013. This increase was driven largely by oil and gas downgrades which formed 43% of new entrants to the list. These statistics provide insight into the increased caution displayed by banks when lending to the energy industry and a growing preference for higher rated counterparties.

One of the first actions taken by virtually all energy lenders, which is indicative of a more conservative financing approach, is the downward revision of lending price decks. According to the Macquarie

US gas rig count

Source: Baker Hughes

◀ Figure 2.



Energy Lender Price survey, from 2009 to 2014, energy lender price decks ranged from 72% to 86% of the West Texas Intermediate (WTI) price settlement point in the front year, typically \$70-80/bbl, and 73% to 90% of WTI five years forward. In the first quarter of 2015, base price decks averaged 101% of WTI in the front year, typically \$50-53/bbl, and 101% of WTI five years forward. Lenders' gas price decks have also fallen with the base case of Henry Hub prices at \$3.62/mmbtu in the front year revised to \$3.02/mmbtu.

This downward revision of lenders' price decks ultimately results in lower debt capacity for an underlying asset than would have been possible the previous year for the same asset. Sponsors that intend to raise bank debt should be aware of this during financial planning and structuring. In a low oil price environment, commodity hedging is typically a mandatory pre-requisite for energy financings as banks seek protection from the downside.

However, hedging at prevalent low oil prices could see sponsors give up some of the possible upside benefits, hedging has become a necessity to obtain lending approval from bank credit committees.

Long term offtake contracts with creditworthy counterparties act as a shield for project credit quality, insulating it from the recent fall in oil prices and ensuring scheduled debt-service payments can be met. This has been a typical feature in most LNG project financings which has facilitated project progress. Note that this does substitute market risk with counterparty risk and deterioration in one or more counterparties will affect project credit quality. The increased scrutiny given to energy financings by banks sometimes also results in longer time required for credit approval processes and financial close.

Structuring projects to be bankable at an early stage is crucial to avoiding financing and project delays which could be costly. In this environment, a well-qualified financial advisor is particularly valuable as there is much less margin for error when approaching banks for financing.

The majority of energy industry analysts are of the view that further significant declines in crude oil prices are unlikely. Price stabilisation and potential appreciation are expected going into the second half of the year with continued increases in 2016.

In the short term, it is unlikely that prices will increase to over \$100/bbl, levels last seen in the first half of 2014. Sources of oil with higher breakeven prices and without hedging are affected the most and will not be able to continue production for long at current prices. Breakeven prices for the majority of US shale oil and gas production are estimated to be in the range of \$60 to \$70/bbl. With WTI per barrel prices in the \$50s, US tight oil production levels could not be sustained for long as additional drilling becomes unprofitable.

The latest Baker Hughes rig count data shows that the number of US oil and gas drilling rigs has fallen below 1000 for the first time since September 2009. New well shale oil production in the US is now below the 320kbopd required to overcome natural

▼ Breakeven prices for the majority of US shale oil and gas production are estimated to be in the range of \$60 to \$70/bbl.





◀ Changes in the price of oil will depend on the short term actions of OPEC countries.

production decline. Saudi Arabia's long term strategy remains unknown to the market but will now have a much greater influence on oil prices than US unconventional production. US refining demand is expected to increase by almost 1.7mmbbl per day in July from seasonal lows in February.

The IEA projects that global demand will increase by 1.1 mmbpd in 2015, an improvement on the agency's previous projection that 2015 demand will grow by less than 1 mmbpd. However, the short term actions of OPEC will be critical to changes in oil price as demonstrated by production growth in March of 890kbopd mainly from Saudi, Iraqi and Libyan supply. If there is a recovery in oil prices, the exact timing and extent of it will remain topical. The EIA projects Brent crude oil prices will average \$59/bbl in 2015 and \$75/bbl in 2016. S&P is also bearish; projecting that Brent will remain at \$55/bbl in 2015 and rise to \$65/bbl in 2016.

An increase in oil prices over the second half of the year would be beneficial to energy companies' balance sheets and enhance the likelihood of obtaining bank financing. The caution of lending institutions is unlikely to ease significantly until there is evidence that oil price increases are sustainable.

Over the short term and possibly the midterm, more pragmatic and cautious bank financing to the energy industry is likely to be the new norm. Whilst price volatility remains, energy companies and projects will need access to all available sources of financing. Bank financing will continue to be essential for the energy industry possibly even more at this time than any other over the last five years. This has been seen in recent M&A activity with banks contributing significantly to bridge financing of over \$12billion for the mergers between Halliburton and Baker Hughes and Royal Dutch Shell and BG Group. Even in a low oil price environment bank financing continues to be available for creditworthy companies and well structured projects.

The market is expecting a slow but steady recovery of oil prices. Current price volatility has enhanced industry efficiency as costs have been reduced and marginal players have been eliminated. The industry is in a good position to recover from the downturn. The bank financing model will continue to be supportive through the current cycle.

Peter Gaw is Managing Director of Oil, Gas and Chemicals for Standard Chartered Bank (www.sc.com).

Outlook on offshore oil and gas in the Arctic

A drop in oil prices has added to the challenges for hydrocarbons operators with Arctic ambitions.

By Jon Marsh
Duesund



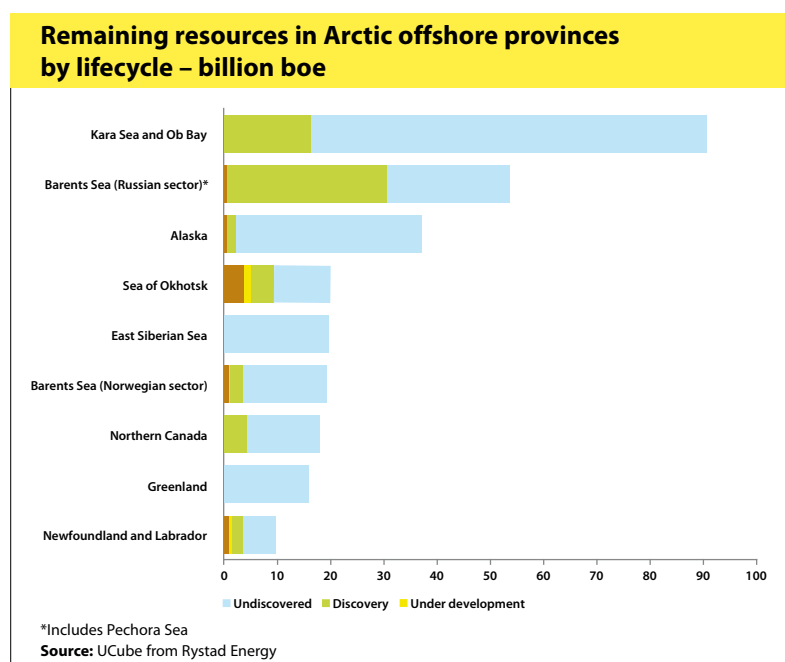
The Arctic is believed to hold vast oil and gas resources and is seen by many as the final frontier within the oil and gas industry. Part of the reason for this belief is the deep sediment layers in the Arctic, which provide good conditions for source rock formation. However, the recent drop in the oil price, combined with environmental issues, has raised concerns as to whether these resources will ever be produced.

According to Rystad Energy's global cost of supply curves, Arctic projects are mainly part of the most costly supply, and are hence more at risk of not being developed than other sources of supply.

Large resource potential in offshore Arctic regions

The resource potential for selected regions is shown in Figure 1. The selection of provinces in the chart is

▼ Figure 1.



based on offshore regions north of the Arctic Circle, but also includes some sub-Arctic provinces, which experience Arctic conditions, e.g. Newfoundland-Labrador off the eastern coast of Canada and the Sea of Okhotsk in Far East Russia. Several of these provinces are believed to hold large oil and gas resources, though around 80% of this potential has not yet been discovered (blue colours) and it depends on successful exploration to be proven. The latter is especially true in some of the frontier Russian provinces and Greenland. In the Kara Sea, for instance, only five exploration wells with no dry holes have been drilled.

From the colour-coding in the chart, it can be seen that some of the resource potential is related to already producing fields (brown), sanctioned fields currently under development (yellow) and discovered non-sanctioned fields (green). Fields in the brown and yellow colour categories are generally situated in either ice-free areas (Newfoundland, Norwegian Barents) or in areas with longer ice-free periods (Sea of Okhotsk). Additionally, there has been production from offshore fields in northern Alaska for years, but these fields have been developed with extended reach drilling from onshore or artificial islands. Parts of the Sakhalin development in the Sea of Okhotsk have also been developed with extended reach wells from shore.

Several challenges related to Arctic developments

The discovered non-sanctioned fields (green) represent future project opportunities, but many large gas discoveries are far from any infrastructure, Shtokman in the Russian Barents being a prime

example. However, there are also big gas discoveries in the Kara Sea and northern Canada. In addition to the lack of infrastructure, other Arctic challenges that stall many developments include, among others, ice, icebergs, icing, darkness, health, safety and environment (e.g. spill containment, personnel evacuation) and remoteness. The latter especially is a big and costly challenge for oil companies, as seen for ExxonMobil and Rosneft's Kara Sea campaign and Cairn's Greenland campaigns.

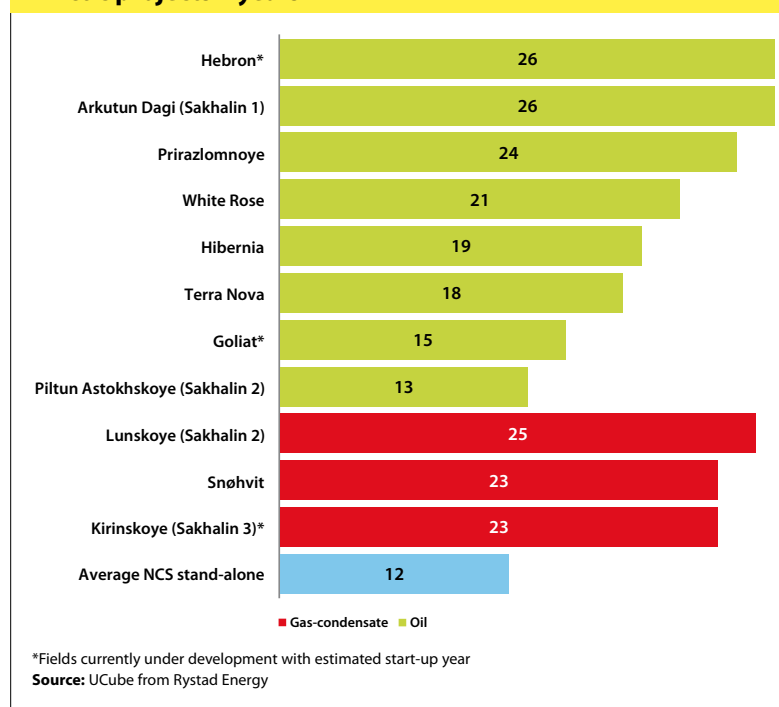
Some of the other underexplored provinces, such as East Siberian Sea and East Greenland, may have even more difficult environments to operate in, so it will take time to prove the potentially big resource potential in the Arctic regions.

In order to see how Arctic challenges affect projects, *Figure 2* shows the historical lead time from discovery to first production for selected projects in Arctic provinces. On average, these projects needed more than 21 years to be developed. In comparison, the last 40 stand-alone projects on the Norwegian Continental Shelf (NCS) have averaged 12 years from discovery to start-up. These projects have been developed during different price regimes, but the lead time nevertheless highlights the challenges with developing Arctic fields. Interestingly, the gas fields have historically not taken much longer to develop compared to oil fields, despite a more significant need for infrastructure. All the gas fields included in the chart have an associated liquefied natural gas (LNG) export facility.

The growing presence of operators in the Arctic

Despite the enormous challenges, several companies have taken Arctic positions over the last years. *Figure 3* shows offshore acreage awarded globally over the last years. As can be seen from the map, a significant share of this acreage has been awarded in Arctic provinces. In total, the Arctic makes up around 30% of the awarded offshore acreage since 2010. Russia provides the bulk of this acreage and awards here alone equal the size of the combined awarded acreage in south-east Asia and South Africa.

Time from discovery to start-up for selected Arctic projects – years

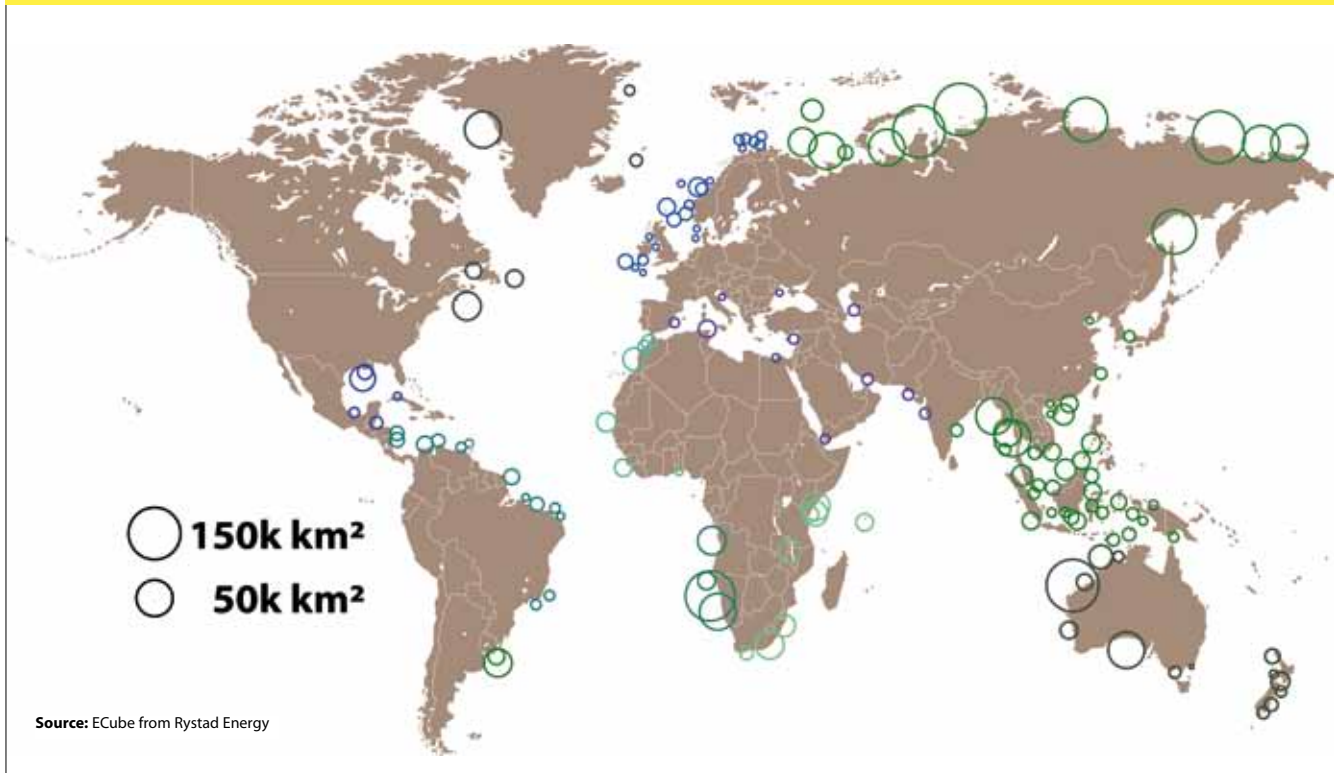


The driver for this is mainly the various joint ventures Rosneft has entered into with foreign companies, most notably ExxonMobil, Statoil and Eni, but also with Asian companies Inpex and ONGC. These cover several provinces, including the Kara Sea, the former disputed area between Russia and Norway, the Laptev Sea, the Chukchi Sea, and the Magadan shelf in the Sea of Okhotsk. Additionally, Gazprom has been awarded large licences in the Barents Sea. Going back further than 2010, there was also significant acreage awarded in Arctic provinces, e.g. Chukchi Sea in Alaska and western Greenland in 2008.

Exploration in the awarded Arctic acreage will take time as most of provinces are very frontier and there are limited ice-free windows when drilling can be performed. Campaigns in the most remote areas require the mobilisation of multiple vessels over a long period of time, which mainly only the big companies can afford. As discussed, one would expect longer lead times from discovery to start-up in Arctic provinces. This is partly driven by the limited ice-free windows that will slow down any

▲ Figure 2.

Awarded offshore exploration acreage 2010-2014 by basin



▲ Figure 3.

appraisal efforts once a discovery has been made. The current sanctions against Russia will also slow down activity, e.g. ExxonMobil has suspended its Kara project indefinitely and no drilling is expected in 2015. Due to commercial reasons, companies such as Chevron and Statoil have also put Arctic exploration efforts on hold in Canada and Greenland, respectively. Shell, on the other hand, intends to resume exploration in the Chukchi Sea in 2015 following a failed campaign back in 2012.

Overall, Arctic exploration is expected to be fairly slow going forward. Shell's big spending on licences in 2008 occurred just before that year's oil crash when the perception was that the era of cheap oil was over. Similarly, ExxonMobil entered into its agreement with Rosneft just as shale oil production started to take off (and later contributed to the current drop in the oil price). As such, we do not expect many significant Arctic exploration campaigns in the short and medium term. In the long term, towards 2020, efforts may pick up again as the oil price may be closer to \$100 per barrel.

Norway and Sakhalin driving Arctic production growth from 2020

Despite significant Arctic challenges and likely limited short-term exploration efforts, there are already several discovered Arctic fields that potentially will be developed in the longer term, as previously indicated in *Figure 1*. As such, a step up in production is possible after 2020 as some of these discoveries will mature, which can be seen in the projected production from Arctic regions given in *Figure 4*.

Currently, the bulk of Arctic offshore production is coming from Sakhalin in Far East Russia and Grand Banks off eastern Canada. In the short term, selected projects will provide a slight growth, e.g. Prirazlomnoye (on stream late 2013) in the Pechora Sea (south-eastern extension of the Barents Sea), the Goliat development in the Norwegian Barents (expected on stream in 2015), Kirinskoye (Sakhalin III, commercial production expected from 2015) and Arkutun-Dagi (Sakhalin I). It should be noted that all these projects have seen significant delays.



◀ The Prirazlomnaya platform in the Pechora Sea. Coming onstream in December 2013, first oil was offloaded on April 18, 2014.

Beyond 2020, stronger growth is expected from several provinces. Major projects include the Bay du Nord development (deepwater Newfoundland), Hebron (Grand Banks), Johan Castberg (Norwegian Barents) and Kirinskoye South (Sakhalin III). All of these projects are expected to be commercially viable, though some of them have yet to select the concept of development.

Looking towards 2030, several other regions may also come into play, e.g. the Kamennomysskoye development in the Ob Bay in Russia, north-west Canada (McKenzie Delta and Beaufort Sea) and more. The profitability of some of these developments is more questionable and the timing is very uncertain, especially in the Russian provinces. The ongoing sanctions against Russia will further stall progress.

Given the current relatively low oil price combined with Arctic challenges, it is clear that field development in new Arctic frontier provinces will be slow, also outside Russia. Shell's struggles in Alaska and constant delays at Shtokman represent some examples of this. The latter project will likely not come on stream before closer to 2030. Regions like Greenland and Kara Sea, which have recently received more attention are not expected to contribute significantly before 2030, which would be in line with the observed historical lead time for

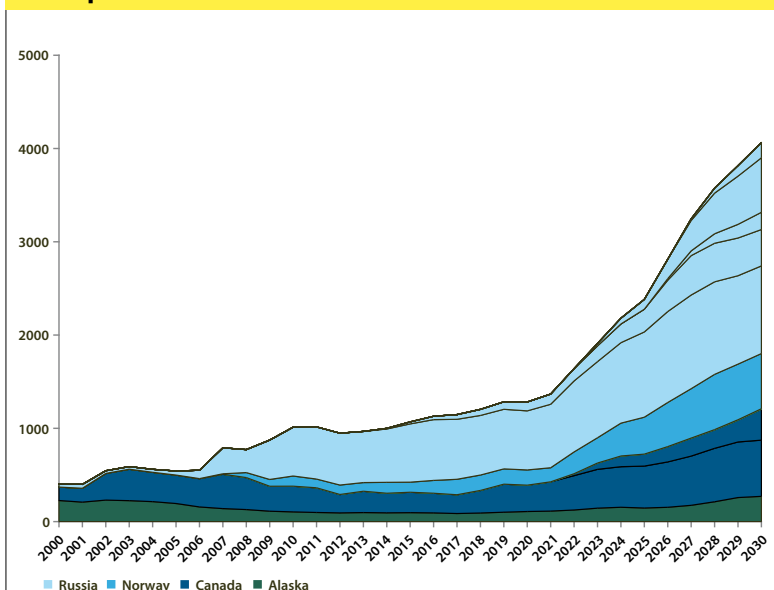
Arctic projects. However, production from Arctic provinces is still expected to gradually grow with a step up after 2020.

Jon Marsh Duesund is a senior project manager at Rystad Energy (www.rystadenergy.com).

This is an edited version of an article published by E&P Magazine.

▼ Figure 4.

Arctic offshore production 2000 to 2030 by country and province – million boe/d



Source: ECube from Rystad Energy

The rise and rise of LNG in Latin America and the Caribbean

An overview of the state of play for the LNG sector across this emerging region.

By Jorge Ciacciarelli



The LNG market in Latin America and the Caribbean has shown dynamic growth in recent years with imports quadrupling between 2009 and 2013. The region accounts for 8% of the world market with imports in 2013 of 17.99 million tonnes and annual exports of 17.92 million tonnes.

The countries that now have an LNG import infrastructure are: Argentina, Chile, Brazil, Mexico, the Dominican Republic and Puerto Rico, while others, such as Uruguay, are in the process of developing terminals. Trinidad and Tobago is the region's longstanding exporter and Peru started exports in 2010.

Several factors have combined to promote the development of LNG in the region. Firstly, there is the need to meet growing energy demand, which is driven by the region's sustained economic growth after the crisis of the late 1990s and early 2000s. Secondly, the flexibility offered by LNG as a source of supply places it as a viable option to provide greater energy security in the face of uncertainties, such as climate variability, in a region with a strong hydroelectric component in its energy generation matrix.

In turn, the abundance of natural gas resources and the capacity to monetise LNG reserves have been vital to the successful development of Trinidad and Tobago and Peru as exporting countries.

The development of the LNG market in the region and its future prospects are heterogeneous depending on each particular case, so a more detailed analysis is required. We reached our conclusions with the Arpel G&E Committee, which is comprised of leaders in companies operating in the region.

Central America and the Caribbean: interesting opportunities for LNG

The small volume of consumption of each country in this region, the possibility of taking advantage of economies of scale, the dependence on imported hydrocarbons to meet energy demand – which translates into a high oil import bill – and the good electrical interconnections in the region, open interesting opportunities for the incorporation of LNG in the energy matrix.

The feasibility of introducing LNG to the Central American region, under the concept of an integrated market focused on thermal generation of electricity, is currently under study at the national and regional level. The proximity to a supplier as Trinidad and Tobago, and the success stories of the Dominican Republic and Puerto Rico support the technical and economic feasibility of LNG in the region.

Trinidad and Tobago: successful export development and long-term challenges

Trinidad and Tobago is the main producer of natural gas in the region, after Mexico, and the main exporter of LNG. The opportunity to monetise the country's natural gas reserves was the main driver

► Trinidad and Tobago has been the region's main LNG exporter since Atlantic LNG began operations in 1999.





for the development of Atlantic LNG, which began operating in 1999. After successive expansions, the plant has four trains, with a combined liquefaction capacity of 14.8 million tonnes per year.

The project was originally leveraged by long-term contracts with the US and Europe, although it has also exported to a number of countries in the Americas and even Asia-Pacific. Countries such as the Dominican Republic or Puerto Rico were able to improve the efficiency of their generation matrix based on the nearby LNG supply.

Anticipating increased exports and limited resources estimated at 0.4 trillion cubic metres (a reserves-to-production ratio of eight years), Trinidad and Tobago should put an emphasis on the undeveloped natural gas resources. Offshore investment is being promoted through bid rounds.

Mexico: the region's main importer

LNG imports to Mexico reached 5.67 million tonnes in 2013, which makes it the largest importer of LNG in the region. These imports are governed by long-term contracts, so it is expected that the country's regasification terminals will continue to be used in the medium term.

Peru: successful exports and a developing domestic market

The development of LNG in Peru is led by the Peru LNG export project, which began its operations in 2010 and has a liquefaction capacity of 4.45 million tonnes per year. The existence of gas reserves in the country, a favourable environment for private investment, and the decision of the government and investors to carry out this initiative were the main drivers for the LNG project.

In 2013, LNG exports added up to a total of 4.25 million tonnes, which were shipped to Mexico, Spain, Japan and South Korea. The development of LNG in Peru has enabled the monetisation of existing natural gas reserves and has fostered economic development.

Peru is currently in the process of developing its domestic market for natural gas beyond Lima, Callao and Ica, under an initiative entitled



◀ Bolivia exports three quarters of its gas production. Developing small-scale LNG capacity will provide greater domestic access to gas.

“Massification of the Use of Natural Gas at the National Level”.

This initiative would involve the development of micro-LNG projects currently under consideration. There is a favourable climate for such investments, supported by the availability of natural gas reserves, the existing liquefaction infrastructure, the limitations in the transportation networks, and the low price of natural gas at the wellhead, which allows for a competitive price after liquefaction, transportation and distribution charges.

Bolivia: abundant resources, small-scale LNG development

Bolivia has a large natural gas surplus, which it exports to Brazil and Argentina by pipelines. With natural gas accounting for 80% of the energy matrix, the country has embarked on the development of small-scale LNG, with the aim of allowing access to cities located far away from pipeline networks.

In Rio Grande, a liquefaction facility is now in the last phase of its construction, with a capacity of 210 tonnes per day, which will allow access to natural gas for 27 cities, and this figure is expected to double in the next two years.

Colombia: several potential scenarios

There are several open scenarios for Colombia regarding LNG development. One of these is the increasing production of hydrocarbons in the country and offshore exploration – this could open



▲ LNG imports cover 13% of Brazil's gas demand; the country has three regasification terminals including this FSRU in Guanabara Bay.

the possibility for the monetisation of reserves through LNG in the future. However, the challenge of coping with climatic phenomena, such as El Niño, makes LNG an attractive option that provides security and flexibility to the energy matrix. Thus, LNG import and export projects are at present under study simultaneously in Colombia.

Brazil: rapid development to meet strong demand

Due to the recent boom in gas-fired power generation in Brazil over the last five years, the country's gas demand has increased substantially from 45 MMm³/d in 2009 to 94 MMm³/d in 2014 (16% compound annual growth rate 2009-14). During the same period, gas supply from local production has grown at almost the same rate as demand, at an average of 13% per year from 2009 to 2014. However, the volume of gas imported from Bolivia, which was half of the net supply in 2009, has grown at the much slower pace of 8% per year, due to contractual and infrastructure limitations.

In this context, the amount of LNG imported increased significantly, from less than 1 MMm³/d in 2009 to 20 MMm³/d in 2014. Installed regasification capacity reached 41 MMm³/d in 2014, and, by 2020, could be increased by 28 MMm³/d depending on the feasibility of newly announced projects by new players. LNG cargoes were purchased in the spot market and under short-term contracts at international market prices, significantly above the local average gas prices for power use.

Whereas Brazil's natural gas production, mostly associated gas, is directed at supplying firm demand (industrial), LNG is imported to supply variable demand. Therefore, the perspectives for the Brazilian LNG imports can vary significantly (from very low levels to 41 MMm³/d) depending on the role of thermal power generation in complementing hydro power, and on the unpredictability of the rain cycle.

In the future, other factors may contribute to LNG import levels and fluctuations, such as the conditions of the Bolivian gas import contract after 2019, the increasing thermal power generation capacity and, possibly, the partial shift of LNG supply to firm demand.

Other aspects to consider are: the gas demand peaks (e.g. summer season) that can further increase LNG import requirements; the development of storage capacity; and, beyond 2020, the plans of EPE, the Brazilian national energy planning company, on shifting the power generation source to become more gas-dependent. As a result, base-load may increase LNG import requirements in the long term and possibly shift it from a spot to a partially long-term contracted profile.

Argentina: potential game changer

In the case of Argentina, the incorporation of the Bahía Blanca terminal in 2008 and the Escobar terminal in 2011, each with a peak regasification capacity of 17 Mm³/day, have provided security and flexibility to meet the growing demand for natural gas in the country, complementing the domestic supply and pipeline imports from Bolivia.

Both terminals cover approximately 8% of the demand in summer, and about 20% in winter, a period when they are at their maximum level of utilisation, thus allowing the country to cope with the strong demand from the residential sector.

In 2014 alone, a total of 104 ship-to-ship transfers (44 in Bahía Blanca and 60 in Escobar) were made, with approximately 9.9 MMm³ of LNG unloaded.

Although at present imports are necessary to supply demand, considering the magnitude of unconventional resources (estimated by EIA at more than 22.4 trillion cubic metres), this could change with imports limited to meeting peak winter demand in the future. Argentina could once again become a major exporter of gas, this time as LNG to countries without pipeline connections.

Chile: rapid adaptation to changing market conditions

Chile used to import significant quantities of gas from Argentina by pipeline but in recent years has diversified its gas supply sources. As a result, Chile has successfully and rapidly adapted to changing market conditions. With the need to supply thriving local industry, LNG has been the option that provided the country with greater energy security.

Chile started importing LNG in 2009 and currently has two regasification terminals with an installed capacity of 4.2 million tonnes per year. In 2013, imports amounted to 2.61 million tonnes, mainly from Trinidad and Tobago.

The country is expected to continue increasing its regasification capacity in view of the increasing energy demand.

Uruguay: the challenge of developing the domestic market

Uruguay is currently developing an LNG import terminal 4km offshore Montevideo. A floating storage and regasification unit (FSRU) will be moored at a jetty protected by a 1.5km breakwater. The terminal, which will have a storage capacity of 263,000m³ and a regasification capacity of 10 Mm³/day, is expected to be operational next year.

The future regasification capacity will exceed by far the current demand for this type of energy. Therefore, the challenge for the next few years lies in developing the domestic market for natural gas, and in utilising existing facilities to become a regional LNG hub. The industrial and electricity generation sectors are expected to drive the growth in demand.

Venezuela: potential game changer

Venezuela has the largest gas reserves in the region, although it is currently importing 1.9 billion cubic metres per year by pipeline from Colombia.

The country is exploring and developing its offshore gas reserves. It is expected that the Cardón IV field, in the northwest of the country, close to the border with Colombia, will start production in 2015.

While there are no confirmed LNG projects, Venezuela has the potential to become a game changer in the region.

Conclusions

The Latin American and Caribbean regions have quickly incorporated LNG into the energy matrix, boosted by the different drivers that have been described above.

At the same time, the region has abundant natural gas resources and a great potential to bring in value and monetise reserves through LNG. Taking advantage of the complementarities between the different countries could leverage the development of LNG in the region, resulting in income from royalties for producing countries.

Thus, there are several potential scenarios for the region, and a long-term agreement among participating countries is vital to achieve an objective that will lead to the overall benefit of these countries. We are working hard on this particular issue through our Gas and Energy Committee.

Jorge Ciacciarelli is the Executive Secretary of the Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean (www.arpel.org).

Petroleum development and future opportunities in East Africa

Kenya and the East African region have a vibrant oil and gas industry and it is a major driver for economies in the area.

By Wanjiku Manyara



▲ Wanjiku Manyara: the oil and gas industry is a major driver for East Africa's economies.

The downstream segment has continued to meet its prime goal of ensuring effective, sufficient supply of petroleum products to all consumer segments against a backdrop of an average of 4% growth annually. Demand for petroleum products continues to increase driven by growing economies in the region and a maturing middle class population. Indeed, 2014 consumption of petroleum products in Kenya stood at approximately 4.826 million cubic metres. On average, this equates to a combined local and export monthly demand of 583,000 cubic metres.

The region's upstream segment continues to diversify and sustain interest especially with significant progress in petroleum exploration.

Continued natural gas and crude oil discoveries, specifically in Tanzania, Uganda and Kenya, remain a strong focus for the region. Economically viable hydrocarbon discoveries for natural gas continue to

be made in Tanzania's onshore and offshore projects with approximately 25 out of the 76 wells drilled discovering gas reserves. The current estimate of natural gas reserves in Tanzania is at 1.3 trillion cubic metres and exploration is ongoing. In Uganda, a total of 127 exploration and appraisal wells have been drilled, with stock tank oil initially in place estimated at 6.5 billion barrels and approximately 1.4 billion barrels of recoverable reserves.

Kenya has drilled 69 wells to date with encouraging discoveries in three basins. Discoveries have been made in 12 of the wells, specifically nine for crude oil in the Tertiary Rift Basin, two for natural gas in offshore Lamu Basin, and another in Anza Basin. Kenya's crude oil reserves in the Tertiary Rift Basin are estimated at about 1 billion barrels.

The downstream sector has in the last 15 years aligned with oil marketing companies (OMCs), ex-

► Substantial gas reserves have been discovered off-shore Tanzania – the drilling ship *Deepsea Metro 1*.





◀ The first delivery of low sulphur diesel went on sale in Kenya in January.

panding, diversifying, restructuring, entering, merging and re-branding, as well as exiting the market.

The numbers of licensed OMCs have increased substantially and more continue to be licensed. This means that existing infrastructure will not sustain this expansion, or the overall pace of development, without additional investments. The oil and gas industry is happy with the progress made towards the development of the petroleum master plans at country and regional level. Final reports from the hydrocarbon-producing areas are expected to guide governments on all areas of the oil and gas sector, in particular those that require development and upgrades commensurate with industry requirements and economic needs.

As we wait for this more systematic, proactive approach to strategically overcome the perennial challenges facing an infrastructure-constrained industry, downstream segment stakeholders need to undertake short-to-medium-term measures to improve efficiency and security of supply. Discussions have intensified on the need to boost the harmonisation and optimal utilisation of existing infrastructure. This can be done through integration of existing public and private sector tankage nat-

ionally. As well as increasing supply and distribution efficiency, the additional tankage will open up a range of business opportunities for the industry, enhance investment and create wealth through employment and entrepreneurship.

The journey towards improved oil and gas standards – especially in environment, health, safety – has been long, with many extraordinary milestones met along the way. These include improving port and terminal safety, eliminating lead in fuels, and reducing sulphur in fuels.

Member countries of the East African Community (EAC) have started marketing diesel with a sulphur content of 50 parts per million (ppm), as well as gasoline with 15ppm and 3% benzene, as per the harmonised EAC standards. EAC is the only region in the world that has shifted to cleaner fuels on a wholesale basis using uniform legislation. The industry through its association, the Petroleum Institute of East Africa (PIEA), has provided leadership in this regard. PIEA is committed to compliance for the benefit of protecting human health and the environment.

We are pleased to note the journey to reducing sulphur in fuels has been long but progressive with



successful milestones. All EAC governments signed up to the 2008 EA Regional Framework Agreement on Air Pollution. This means all EAC governments are committed to enact regulations to reduce sulphur in imported gasoline for automotive use to 500ppm by 2010. Subsequently, the review of the standards that reduced the sulphur content from 5,000 to 500 ppm for imported finished gasoline were gazetted in 2010 and enforced accordingly. The collaboration between industry, government ministries, regulatory agencies and non-governmental agencies made it possible to develop and adopt regional harmonised low sulphur standards for petroleum products.

The benefits of low sulphur diesel (LSD) cannot be understated, especially because of the adverse impact that high levels of sulphur have on human health and the environment. Additionally, LSD allows for effective use of emission control systems for diesel vehicles and equipment, such as high-pressure injection, computer controls and exhaust gas recirculation. This reduces pollution and promotes cleaner air and better health.

Access to cleaner, modern, safe and efficient household petroleum energy remains elusive yet it is a low hanging fruit. The necessity to implement the proposed clear and brave policy shift, as contained in Kenya's National Energy & Petroleum (NE&P) Policy, from unsustainable energy options, such as biomass, to cleaner modern options, such as liquefied petroleum gas (LPG), cannot be understated.

A multi-sector sub-committee has been formed by the Kenyan government to draw up proposals and strategies that will promote utilisation of cleaner household fuels, including LPG, for implementation has commenced its work.

The PIEA will co-host the second Africa LPG Summit in June 2015 for purposes of bringing the region together in determining workable mechanisms, technologies and innovations to be rolled out nationally to enhance LPG consumption sustainably.

The midstream and downstream petroleum segments, which have been vibrant in Kenya for

many years, have been successful in developing local skills and capabilities through training petroleum specialists. This has been done through PIEA's specialised School of Petroleum Studies and local workers for the oil and gas industry are now available.

PIEA is using the same approach in building capacity for the relatively young upstream segment with the aim of effectively replicating training for local development. The fast-tracking of this tried and tested approach is expected to accelerate Kenya's aspiration to be scientifically and technologically independent, and to maximise value from oil and gas resources.

The importance of systematically developing capacities and capabilities to facilitate the utilisation of Kenyan people in the oil and gas value chain, and thus promote local wealth creation through employment and entrepreneurship, cannot be underestimated. Stakeholders need not be apologetic in demanding that young Africans must be equipped with modern skills and the knowledge they need to find African solutions to Africa's challenges.

In Kenya, the oil and gas industry is set to undergo continuous transformation once the revised NE&P policy and statutes are approved and implemented. The government, through the Ministry of Energy & Petroleum, spearheaded a thorough consultative process. This incorporated the formulation of the NE&P Policy, and a review of existing energy statutes, including the Energy Act and the Exploration and Production Act.

While it is impossible to develop policies and laws that are perfect for all stakeholders, it is worth recognising that the NE&P Policy is sufficient to establish a foundation to guide the oil and gas industry reforms. It is industry's expectation that the Kenyan government will monitor and evaluate the full implementation of this policy, as well as fully enforcing the law, to ensure that the gains in the policy and statutes benefit all Kenyans.

Wanjiku Manyara is the General Manager of the Petroleum Institute of East Africa (www.petroleum.co.ke).

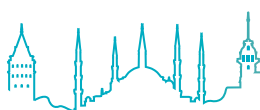
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The bright future of India's petroleum industry

With a growing economy and population, the opportunities available in the Indian hydrocarbon industry are immense.

By Georgia Lewis

India contributes 6.4% of the global GDP. Average real growth between now and 2018 is expected to be 6.5%. Since 2000, India has received total foreign investment of \$306.88 billion. By 2020, India is projected to be the world's largest middle class consumer market. And this increase in the income levels of the Indian middle classes is leading to greater aspirations and an increase in demand for sophisticated public and private services. As such, India is becoming a seller's paradise.

Additionally, India has a high quality human workforce. By 2025, India will be home to 25% of the world's skilled workers. India has the world's second largest pool of English-speaking professionals and it is a young nation of 1.2 billion people with a median age of 25 years.

The country is a highly rated investment environment. According to UNCTAD, India is the

third-most attractive destination for foreign direct investment (FDI) in the world (*World Investment Prospects Survey*, 2012-2014). By 2017, India is expected to attract \$1 trillion in infrastructure investment and be the second-largest economy in manufacturing in the world. Fifty-four Indian companies have made their mark in Forbes' annual list of the world's 2,000 largest and most powerful public companies.

Policy initiatives are being advanced for the growth of the Indian economy and better governance. For example, the government is putting in place transparent systems and time-bound delivery of state services, as well as the creation of a policy environment which is predictable, transparent and fair. The tax regime is being rationalised and simplified to make it non-adversarial and conducive to investment, enterprise and growth.

► India is expected to be the second largest manufacturing economy in the world by 2017.



This simplification of procedures and improved trade infrastructure is also aimed at strengthening India's share in global trade. The expected reduced transaction times and costs will make India a more attractive trading partner, including in the global energy market.

Indian energy policy for a sustainable future

A comprehensive National Energy Policy will include details on expanding energy access with a mix of new and renewable sources as well as fossil fuels. An important component of this policy will be to bring all Indian households and industries onto the gas grid and to promote cleaner fuels to bring down pollution levels. The Jawaharlal Nehru National Solar Mission and nuclear power will be expanded, and coal sector reforms for the purpose of encouraging private sector investment are planned.

Energy demand is on the rise with India's rapid social and economic development. Nobody should be left behind – India's growth should be inclusive. But energy supply needs to catch up with demand. Currently, hydrocarbon demand is much greater than domestic crude oil and natural gas production. Indeed, India is the fourth-highest energy consumer in the world with a 4.7% share of global primary energy consumption. Oil and gas contribute 37.2% of the country's primary energy consumption.

To create a level playing field so private investors are on par with national oil companies (NOCs), they need to be given the same fiscal and contract terms. Exploration blocks will be offered through a transparent and international competitive bidding process.

The acquisition of overseas oil and gas assets, the encouragement of FDI, and the development of alternative energy sources and fuels are important aspects of the Indian government's strategy to enhance energy security, while promoting conservation and environmentally friendly energy production.

Technology is another important pillar of India's new energy policy. Implementing the best techno-



Technology is a pillar of India's new energy policy.

logy in the upstream and downstream sectors, and development of vital infrastructure such as production facilities, refineries and services is essential to the future success of India's energy growth.

Foreign direct investment policy

FDI is considered crucial to the future success and sustainable, long-term development of the Indian energy industry.

The Indian government offers foreign investors automatic access and up to 100% of FDI Capital/Equity for investments in: exploration of oil and

India seeks foreign investment to increase refinery capacity.





natural gas fields; infrastructure related to marketing of petroleum products and natural gas; marketing of natural gas and petroleum products; petroleum product and natural gas pipelines; LNG regasification infrastructure; and petroleum refining in the private sector.

Additionally, the new Indian energy policy seeks to allow foreign investors stakes of up to 49% in petroleum refining by the Central Public Sector Enterprises (CPSEs) without any disinvestment or dilution of domestic equity in the existing CPSEs.

Partnering in oil and gas equity

The Indian government is encouraging NOCs to pursue equity oil and gas opportunities overseas. One such NOC, ONGC Videsh Limited (OVL), produced about 8.357 million tonnes of oil equivalent during 2013-14 from its assets in Brazil, Colombia, Russia, South Sudan, Sudan, Syria and Vietnam. Overall, India's NOCs – ONGC Videsh, Indian Oil Corporation, Oil India Limited, Bharat Petroleum Corporation, Hindustan Petroleum Corporation and GAIL Limited – have acquired E&P assets in more than 20 countries. Investment by these NOCs is worth more than \$21 billion.

Additionally, India is urging outside investment in the country's oil and gas E&P for a number of reasons. These include: an improved policy environment that is uniform, supportive and progressive; a good prognosis for the hydrocarbons industry with plenty of opportunities for exploration; improved infrastructure with surplus refining capacity and an extensive natural gas pipeline network; and international pricing for petroleum products.

Proposed policy initiatives in the hydrocarbon upstream sector

Above all, a uniform licensing policy is essential. The challenge is that under India's New Exploration Licensing Policy (NELP), only conventional oil and gas exploration rights exist, and under coal-bed methane (CBM) policy, only CBM exploration rights are available. New policy is being formulated whereby stakeholders can explore and extract all

hydrocarbon resources, including conventional oil and gas, CBM and shale reserves.

In regard to shale oil and gas, the challenge is the need for shale gas exploration to take place in conjunction with conventional hydrocarbon operations. Again, the uniform licensing policy is an essential initiative – shale gas exploration for other blocks will now be covered by this policy.

Data policy and its potential

Currently, there is a lack of geo-scientific data for sedimentary basins. To counteract this, a new policy initiative provides for a non-exclusive, multi-client model of data generation. In this model, the service provider assumes all operational and financial risks and invests their own funds and resources. The government receives the data free of charge and the service provider has the right to sell the data for 10 years.

A national data repository (NDR) is another new policy initiative for the Indian energy industry. Currently, exploration blocks are carved out by the Directorate General of Hydrocarbons. The NDR will allow operators to identify blocks and make it possible to bid on an open acreage approach.

This data policy will make it easier for operators to obtain information on the blocks on which they want to bid. Under the NELP, there are 52 blocks proposed to be on offer. There are 16 deep water blocks (Area: 88,594km²), 16 shallow water blocks (Area: 37,342km²), and 20 land-based blocks (Area: 22,273km²). The total area of all these blocks is 148,209km². These have been categorised according to whether they are potentially productive or have been proven to be productive. All necessary statutory clearances have been taken.

The expanding economy and population will continue to be the drivers for oil and gas. At present, energy consumption per capita in India is just 26% of the world average but this is growing. The opportunities for investment are immense.

Georgia Lewis is the Managing Editor of International Systems and Communications Limited (www.isyscom.com).



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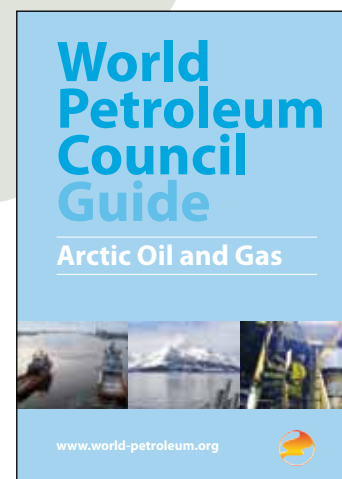
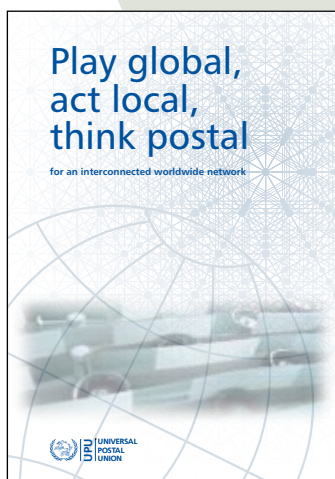
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Overview of the Russian oil industry: Challenges and prospects

Expansion in Asia is critical for the ongoing growth of the Russian oil industry.

By Ekaterina
Grushevenko, Dmitry
Grushevenko and
Anna Galkina

Russia is the second largest oil producer in the world with 13% of the global oil supply in 2014; therefore, it is very important for consumers and producers to have a vision of the current state and long-term prospects of Russian oil industry development. This is even more important since the current oil price conjecture creates huge uncertainties.

The Russian oil industry is entering a new stage of development. These changes are taking place concurrently with several external factors: the global economic crisis; demand slowdown in domestic and foreign markets; the US shale revolution; and increased supply of hydrocarbons, resulting in a lower price environment. Internal factors are also affecting the Russian oil industry: the depletion of

cheap oil fields and the necessity to explore new hard-to-reach and expensive-to-develop oil and gas provinces, growing corporate concentration, and increasing problems with access to finance. As a result, the oil industry is going through a difficult transition period, the success of which will define not only Russia's position in the global energy market, but also its economic welfare.

The main challenges for the Russian oil industry

According to the Russian Energy Ministry, in the last five years Russian oil production has been growing steadily from 10.1 MMb/d in 2010 to 10.5 MMb/d in 2014. The main centre of crude oil production is

▼ Igor Sechin, President of Rosneft, addressing the 21st World Petroleum Congress in Moscow. Rosneft's growth in the last decade has made it Russia's leading petroleum company.



located in Western Siberia. More than 60% of crude oil in Russia is produced in this region.

Currently the Russian oil industry is oriented to the West. This presents great risks for Russian oil exporters in case of further decline in European oil demand. Diversification of export markets requires significant investments for building export infrastructure to Asia, and for meeting demand in the eastern part of Russia.

A strong decline in production rates in existing oil fields is another challenge for the Russian oil industry, with an expected natural decline of a maximum of around 1 MMb/d. In the years up to 2010, the pace of this decline increased significantly, reaching an annual rate of 11%. To maintain production volumes, it is necessary to constantly introduce new fields into development. The situation is exacerbated by the fact that greenfield sites are located mostly in remote areas with severe climatic conditions and associated technical difficulties. Significant investments are required to bring these fields into development.

Russian oil production dynamics depend largely on the companies' ability to bring new fields into operation in due time. Additionally, the pace of introducing state-of-the-art technologies needs to be sufficient to maintain production levels at the existing fields.

In the past five years, in response to these challenges, the eastern part of the country (including the Far East and Eastern Siberia) has been demonstrating sustainable growth in crude oil production. Cumulative growth of crude oil production here amounted to 88% in 2010-2014. This rapid growth is provided by the new exploration and production projects in this region such as the Talakanskoe, Yurubchensko-Takhomskoe, Verkhnechonskoe and Vankor oil fields.

Another way to maintain the level of oil production in Russia would be to increase oil recovery from existing fields. Currently, the country's recovery factor is 34%. Raising the recovery rate to global levels would require adding significant additional wells, located in the areas with existing infra-

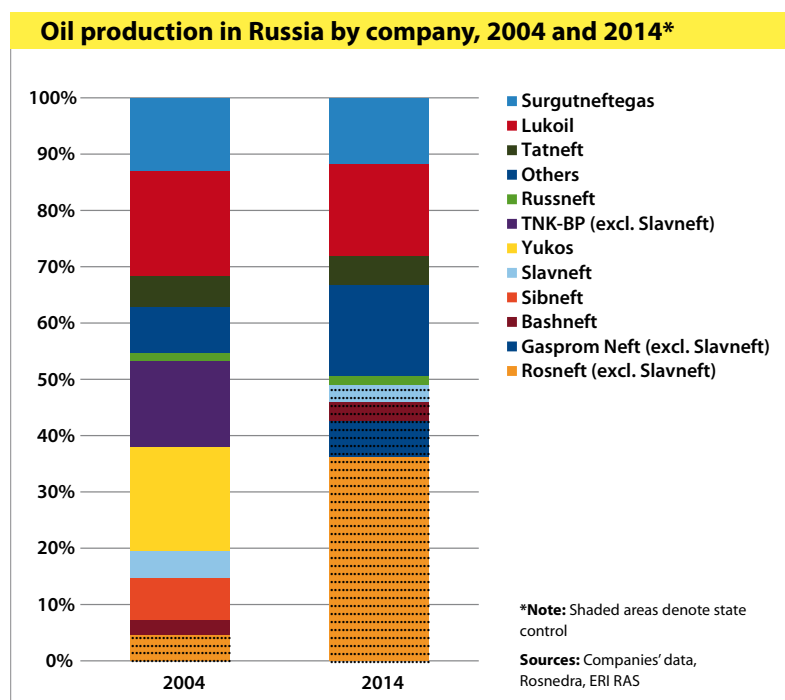
structure, to the field development. However, the use of tertiary oil recovery techniques, mainly enhanced oil recovery methods (EOR), is not cost-effective under the existing tax regime.

Development of stranded oil reserves, such as the Bazhenov shale oil basin in Western Siberia and Arctic locations, may also contribute to stable production. However, these are long-term projects, which would not pay off until the end of the 2020s. These projects would also require the development of major technological competencies, greater involvement of foreign partners and the creation of a favourable regulatory environment, such as low taxes and ease of access. These factors are not currently in place.

Maintaining the pace of oil production is complicated by the recent introduction of Western economic and technical sanctions. The biggest problem is the restrictions applied to waters deeper than 150m for technologies of oil exploration and production, and to oil exploration and production in the offshore area north of the Arctic Circle. On the one hand, this technological ban will affect new deepwater projects in the north, such as the Pechora, Kara and Okhotsk Seas, as well as the Black Sea. But on the other hand, we expect that in the medium term, Russian equipment manufacturers will be able to produce their own machinery. This will eventually reduce Russian oil industry dependence on imports.

Around 40% of primary processing capacities in the Russian oil refining industry are situated in the European part of the country. This leads to the fact that the main consumption and export of oil products occurs in the European part of the country and to European destinations. In the eastern part of the country, there is a shortage of petroleum products, which is covered by neighbouring regions. As such, additional investment will be required soon for the construction of refineries in the far eastern regions, and these refineries will be designated for domestic demand and export.

The closure of mini-refineries with low refining depth (a low ratio of obtained petroleum products



▲ Figure 1.

to the original quantity of crude oil) presents another challenge to Russian oil refining projects. These refineries are situated primarily in the southern part of the country and are focused on exporting low-quality diesel fractions to Europe. The presence of such mini-refineries reduces the value-added component of petroleum products, and reduces the competitiveness of highly complex refineries.

To overcome these challenges, the Russian oil industry needs a radical reduction in the costs of investment projects, together with a thorough evaluation of their cost-effectiveness and potential risks. It is necessary to rank all investment projects and reject or postpone the implementation of the inefficient ones. The cost of domestic energy projects is typically several times greater than equivalent projects found elsewhere, while many completed projects have been under-utilised. Creating a favourable regulatory environment for high-tech production and refining technologies is another important measure.

The corporate landscape

By the late 1990s, the major Russian oil production assets were concentrated in the hands of private

companies such as Yukos, Sibneft, Lukoil and Surgutneftegas – which had all become world-class vertically-integrated oil companies, while state-controlled Rosneft accounted for just 4% of the country's oil production. In the course of the last decade, however, oil production has started to become concentrated in the hands of state-controlled companies such as Rosneft and Gazprom Neft.

After a series of acquisitions (initially assets from Yukos, then from TNK-BP) Rosneft's share of total Russian production reached 40% in 2014.

However, Rosneft is not the only state-controlled asset in the Russian oil sector. Since 2007, Gazprom's oil assets have been consolidated within Gazprom Neft, which provides around 6% of Russian oil, excluding Slavneft's share (Slavneft is controlled equally by Gazprom Neft and Rosneft). Following Rosneft's acquisition of TNK-BP, Slavneft itself may also be considered to be an entirely state-controlled asset, as it is now half-owned by Rosneft and half by Gazprom Neft. Moreover, at the end of 2014, the stake of Bashneft held by Russia's multi-industry holding company AFK Sistema was nationalised. As a result, the share of state-controlled production (Rosneft, Gazprom Neft, Bashneft and Slavneft) has increased more than 13-fold to 50% in the last 10 years (see Figure 1).

Private companies currently provide about half of Russia's total liquid fuel production, but this share will probably decrease in the medium term as Gazprom Neft and Rosneft are likely to be the main engines of oil production growth in the coming years. All major new investment projects and the majority of oil production growth are provided by state-controlled companies.

Therefore today, when oil and petroleum products account for the largest share of the country's federal budget revenues – 45% in 2014 – and the state needs this money badly, it is reasonable to expect that the state will continue to use this powerful tool to control such an important industry, generating a “multiplier effect” for other industries. The Russian oil sector might therefore see a further increase of state involvement, together with further consolidation.



The long-term outlook for the Russian oil sector

Production

According to estimates by the Energy Research Institute of the Russian Academy of Sciences, Russian crude oil and gas condensate production is expected to decrease by at least 10%: from 10.5 MMb/d in 2014 to 9.5 MMb/d by 2035 (see Figure 2). This reduction in production will be, for the most part, brought about by the working out of already exploited deposits in the main oil producing regions of the country, which are located in Western Siberia. The main reason for the drop in oil production in this region is the lack of EOR, resulting from poor state support for using these methods.

Despite the fall in production, Russian production capacities will continue to be concentrated in Western Siberia, with its share accounting for 51% of all crude oil and gas condensate production by 2035. The drop in production is partially offset by the commissioning of fields in Eastern Siberia and Russia's Far East. For example, production in Eastern Siberia is projected to grow from 0.7 MMb/d in 2014 to 1 MMb/d in 2035, while production in the Far East is projected to increase from 0.5 MMb/d to 0.8 MMb/d by 2025, although it will then fall to 0.7 MMb/d by 2035.

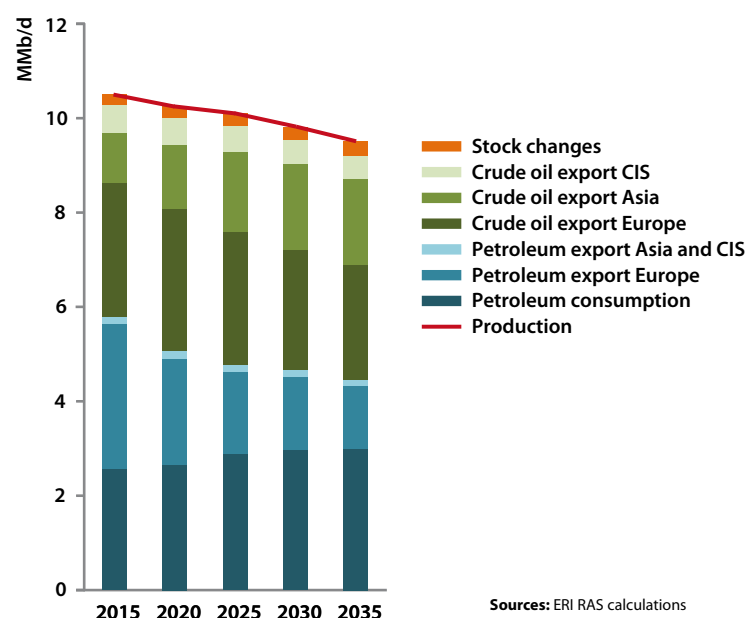
Despite the pessimistic outlook for oil production, Russia maintains the potential to preserve its important position in the global oil market. To maximise this potential, Russia would need to resolve issues related to successful testing of new technologies, stranded resources and cost control in the new prospects.

Refineries

Refinery volumes will decline by 23% from 5.9 MMb/d in 2014 to 4.5 MMb/d by 2035. This decline will occur due to the decommissioning of small and inefficient refineries.

The projected decline in utilisation is due primarily to a glut of oil products in the European market. Given falling demand for petroleum products in 2015-2020, suppliers of refined products in Russia, the Middle East, Asia and Europe itself will compete for European consumers, while maintain-

Russian oil production outlook



ing deliveries of diesel fuel from the USA. After 2020, a gradual recovery of primary oil refining is expected in Russia. A systematic growth in the production of petroleum motor fuels and feedstock for the petrochemicals industry is also projected – this is due to an increase of refining depth from 71% in 2010 to 93% in 2035, and an increase in the yield of light oil products from 55% to 73%.

During the forecast period fuel oil output will show the biggest decline, down 75% by 2035. This is caused by oil refinery upgrading and the complete phasing out of fuel oil in power generation in favour of natural gas and coal.

Export

Russian crude oil exports in 2014-2035 will show moderate growth of 8%, from 4.4 MMb/d to 4.7 MMb/d due to a decline in refinery output (see Figure 2).

Diversification of export routes and partial re-orientation from the European market to the Asian market are the main points of export policy in Russia. In order to achieve this strategic goal, Russia plans to expand all eastern transportation capacities (Eastern Siberia-Pacific Ocean pipeline system and marine oil terminals) by nearly two-fold. As a

▲ Figure 2.



► Extreme operating conditions are the norm for Russia's oil and gas companies – the ice-class oil tanker *Mikhail Ulyanov* approaching Gazprom Neft's Prirazlomnaya rig in the Pechora Sea.



result, transportation capacity for crude oil export to the Asian market will increase by 75% from 1 MMb/d in 2014 to 1.8 MMb/d in 2035, while European exports will decline by 15% from 2.9 MMb/d to 2.4 MMb/d in the same period.

Among the CIS countries, Belarus took almost half of all Russian deliveries to the region in 2014. By 2035 Belarus will take 0.24 MMb/d, with a further 0.12 MMb/d of deliveries to the CIS going to Ukraine. Despite the decline in its own oil exports to the West, Russia will increase its significance as a transit country, mainly from fields in Kazakhstan via the Caspian Pipeline Consortium system. This transports oil to the Novorossiysk-2 terminal on Russia's Black Sea coast.

Export of petroleum products will fall sharply during the forecast period from 3 MMb/d to 1.5 MMb/d. The western direction retains its significance for the Russian oil industry: by 2035 up to 90% of total Russian petroleum product exports will go to Europe, although there will be an unavoidable fall in absolute volumes from the present 2.9 MMb/d to 1.3 MMb/d.

Therefore, a reduction in the interdependence of Russia and Europe in the liquid fuels market is

expected in the forecast period, with a simultaneous reorientation of exports of crude oil to the East.

Conclusions

In the foreseeable future, the Russian oil industry will undergo serious institutional changes in response to internal and external challenges.

Production growth observed since the mid-1990s will be replaced by a significant decline in production from the existing fields and a transfer of new producing areas to Eastern Siberia and the Far East. The main efforts in setting up export routes and investment projects will focus on increasing supplies to the Asia-Pacific region. There will be a decrease in supplies to Europe.

Oil refining will be subject to sweeping changes, with significant upgrades made to change the petroleum products basket instead of growth in gross primary processing.

Ekaterina Grushevenko is a research associate, and Dmitry Grushevenko and Anna Galkina are researchers at the Energy Research Institute of the Russian Academy of Sciences (www.eriras.ru).



Industry innovation

- **John S. Watson, the Chairman and CEO of Chevron**, leads this section of the yearbook with an examination of how technology in the energy industry has improved the lives of people in the Gulf of Mexico and will continue to do so.
- Next, the results of the WPC Youth Survey are analysed by **Katharina Gruenberg** and **Csaba Zsótér, WPC Youth Representatives for the UK and Hungary** respectively. The opportunity to work in a high tech environment turned out to be a popular attraction of the energy industry for many respondents.
- This section continues with a contribution from **Tako Koning, Senior Petroleum Geologist and Business Development Manager for Gaffney, Cline & Associates in Luanda, Angola**. He writes about the potential for Angola's diverse oil and gas plays to achieve economic and energy security for the southern African country.
- **Chris Beddoes, the former Director General of Fuels Europe**, explains the important role of the European refining industry in creating cleaner fuels for global consumers and industry.
- **J. Gerardo Uría, Director of Membership and Global Industry Services for the American Petroleum Institute**, discusses the ongoing development and improvement of the US shale energy sector.
- The development of floating LNG – for liquefaction and regasification – is opening up new opportunities for the natural gas business around the world. **Mark Blacklock, Editor-in-Chief at International Systems & Communications**, looks at the global picture, and **Datuk Abdullah Karim, Vice President and Venture Director LNG Projects, for Petronas** focuses on the company's projects.

Engineering progress and possibilities

Technical innovation is driving improved results and greater cost efficiencies in the industry as it strives to meet growing demand for energy – especially in developing countries.

By John S. Watson



▲ John S. Watson: expectations for our industry are at an all-time high.

Over the past 150 years, abundant affordable energy supplies have enabled advances in living standards and propelled economic expansion around the globe. From the industrial manufacturing gains of the early 20th century to the digital renaissance of the present day, energy's availability and reliability have brought light, heat, mobility and connectivity to billions of people worldwide.

Today the energy industry continues to support global economies, improving the quality of life in developed and developing nations. Chevron is playing a leading role in that process. Every day, our employees are discovering, developing and delivering energy safely, affordably and at scale. At Chevron we are well aware that expectations for our industry are at an all-time high, and collect-

ively we must continue to enhance our safety processes and protocols and operate our facilities even more efficiently.

Technology helps to achieve those goals, building upon the dedication and hard work of employees and business partners as we discover new production frontiers in tough environments at challenging depths. Across the industry, innovation is improving efficiencies, lowering costs and helping to ensure the safe, responsible development of crude oil and natural gas.

Investment and commitment in the US Gulf of Mexico

A great example of new technologies driving improved results and greater cost efficiencies can

► The Jack/St Malo floating production unit is the largest of its kind operating in the Gulf of Mexico.



be found at our Jack and St Malo fields in the US Gulf of Mexico.

Chevron and its legacy companies have been exploring for and developing oil and natural gas resources in the Gulf for more than 75 years. Today, we are among the top leaseholders and producers in the area. We firmly believe in the Gulf's continued viability, having sanctioned more than \$20 billion in new projects over the past decade that are focused on delivering significant new production.

Jack/St Malo's floating production unit (FPU) is centred between the Jack and St Malo fields in the Gulf's Lower Tertiary Trend. The deepwater development is the fifth in the Gulf of Mexico operated by Chevron. Discovered in 2004 and 2003 respectively, these fields represent two of Chevron's largest finds in the Lower Tertiary.

Chevron commenced crude oil and natural gas production at Jack/St Malo in December 2014. Production is expected to ramp up over the next several years to an average daily rate of 94,000 barrels of crude oil and 595,000 cubic metres of natural gas. Current technologies are anticipated to recover in excess of 500 million boe over Jack/St Malo's 30-year estimated production life.

Engineering at scale

The Jack and St Malo fields were co-developed with two subsea centres, 40km apart, tied back to the centralised FPU. Jack/St Malo is the largest structure of its kind in the Gulf. The facility displaces 160,000 tonnes – roughly 1.5 times the displacement of the world's largest aircraft carrier. Utilising hundreds of kilometres of pipe and some of the deepest wells in the world, workers at the FPU are developing resources from depths of 7,950m below the surface.

Jack/St Malo employs a multitude of technologies to safely develop and deliver energy, while lowering costs and improving outcomes. To make the discoveries at Jack/St Malo, Chevron used advanced seismic imaging to visualise a reservoir nearly 430m thick in places. To develop the fields, we deployed

enhanced completion technologies, installed subsea pumps to push oil up from the sea floor and built the area's first deepwater pipeline to link production to the market.

Advancing technology and advancing the industry

With the high cost of drilling a deepwater exploration well in the Gulf of Mexico, it is critical to find and hit the right spot on the first try. That can be challenging, given the deepwater environment with complex geologic faults and complicated salt features. To improve our understanding of subsur-

◀ The *Discoverer Deep Seas* drillship found the Jack field in July 2004.



face reservoir structures at Jack/St Malo, Chevron used a seismic technology known as Ocean Bottom Nodes (OBN).

With OBN technology, remotely operated vehicles safely position 45kg receivers, or nodes, in a grid directly on the seafloor enabling collection of high-quality seismic data with broader bandwidth and easier survey repeatability.

Enhanced seismic capture through OBN helps optimise the placement and the number of wells, ultimately lowering costs and increasing recovery. At Jack/St Malo, 1,100 nodes were placed on the seafloor at a water depth of 2,134m. The back-to-back surveys lasted 10 months and broke several industry records, including number of nodes simultaneously deployed, longest acquisition schedule, deepest water and the largest source area.

Another notable achievement at Jack/St Malo involved new single-trip, multizone well completion technology. Chevron helped to develop the new technology, allowing the team to stimulate multiple zones of the reservoir in a single run of the equipment, dramatically increasing completion efficiency and generating savings. At one well in the Jack Field, Chevron stimulated a record-breaking six zones and safely pumped more than 900,000kg of proppant into the target zones in just a few days. This process would normally last a month.

Finally, Chevron is using technology to extend subsea operating limits far beyond industry aver-

ages, bringing unprecedented power to the seafloor. Subsea boosting is not a new approach. At Jack/St Malo, however, from the subsea boosting depth to the pressure rating to the power of the pump, there is nothing else comparable in the industry.

Jack/St Malo's three subsea pumps are built to withstand 13,000 pounds per square inch (896 bar) of pressure, are installed in 2,134m of water, and are each capable of generating 3MW of shaft power – collectively a new industry record representing significant advancement over previous models.

Policies driving continued growth

Innovative technology is driving record-breaking outcomes at Jack/St Malo. As a result, the Gulf's largest FPU will bring to market the energy required to heat homes, transport people millions of kilometres and develop consumer products used every day.

Access to ample supplies of energy remains the clearest need of more than a billion people on the planet, especially those in developing countries. Success stories such as Jack/St Malo will become even more critical over the coming years as energy demand is projected to increase by roughly 40% within the next two decades. To help meet this demand growth, energy-producing nations, whether the United States of America or elsewhere, must craft commonsense policies supporting the development of affordable, reliable energy resources – and enable those resources to meet the needs of the market.

Energy is a cornerstone of economic growth and helps to improve the quality of life for communities around the globe. When the right policies meet the right expertise, innovative advances are made within the energy industry and new depths are reached. Nowhere is that more evident than at Chevron's Jack/St Malo development.

John S. Watson is Chairman of the Board and CEO of Chevron Corporation (www.chevron.com).

▼ The Jack and St Malo fields lie in the Gulf of Mexico's Lower Tertiary Trend.

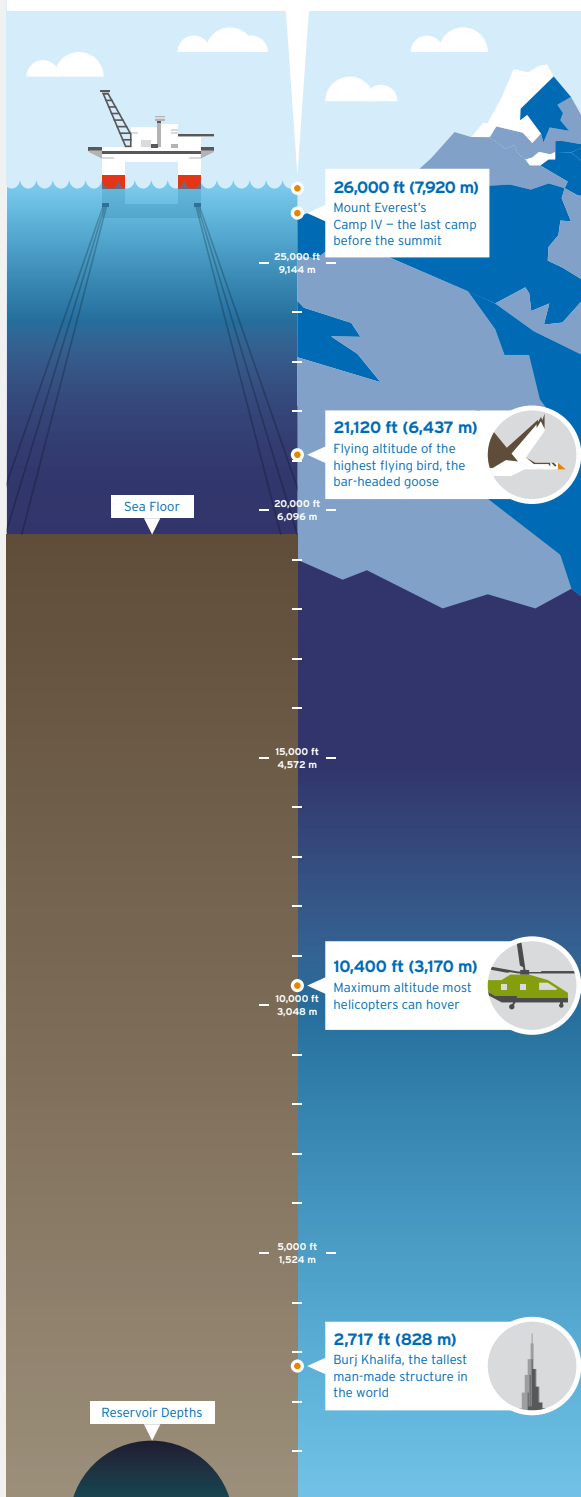




SCALING UP PRODUCTION

Deepwater production goes big with Chevron's Jack/St. Malo Project.

The Jack St. Malo floating production unit sits in 7,000 ft (2,134 m) of water, with reservoirs beginning at 19,500 ft (5,944 m) beneath the seabed. **THAT'S A TOTAL DEPTH OF 26,500 ft (8,077 m).**



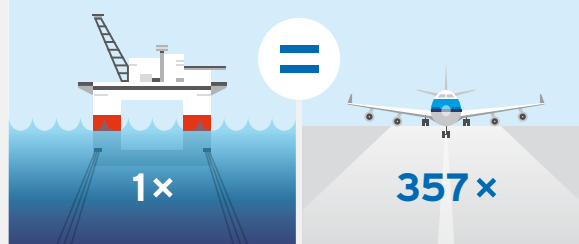
The Jack/St. Malo Project infrastructure is nearly as wide as

THE STATE OF RHODE ISLAND.



The Jack St. Malo floating production unit displaces the water equivalent of

357 FULLY LOADED 747s.



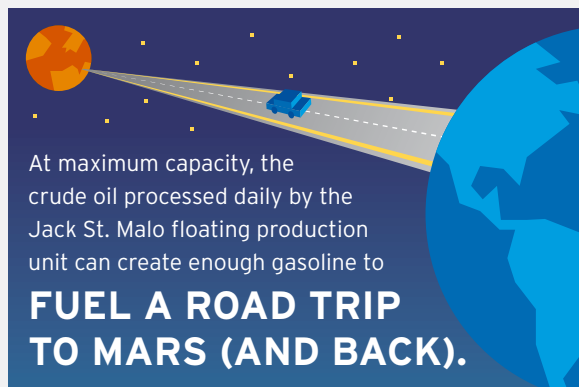
The length of new oil pipeline measures 136 miles (219 km) and would

STRETCH ACROSS ITALY.



At maximum capacity, the crude oil processed daily by the Jack St. Malo floating production unit can create enough gasoline to

FUEL A ROAD TRIP TO MARS (AND BACK).



STATEMENTS ARE BASED ON THE FOLLOWING FACTS (CLOCKWISE, FROM UPPER LEFT):

- 1) The facility sits in 7,000 feet of water, with reservoir depths at 26,500 feet.
- 2) The field layout includes two separate fields 25 miles apart.
- 3) The floating production unit has a water displacement of 160,000 metric tons.
- 4) A 136-mile crude oil pipeline was installed to connect the Jack and St. Malo fields to an existing platform.
- 5) The floating production unit has an initial capacity for 170,000 barrels of oil per day.

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The WPC Youth Survey 2014

Feedback from young professionals is essential for attracting and retaining talent and ensuring the oil and gas industry moves forward with technology and social responsibility.

By Katharina
Gruenberg and
Csaba Zsótér

The World Petroleum Council Youth Committee finalised its *WPC Youth Survey 2014*. The online survey was distributed through the global WPC network, including 70 member countries. It targeted students and young professionals across the world regarding their career and perception of the oil and gas industry. The survey consisted of 26 questions addressing some of the important issues facing young people in the industry, including:

- Respondents' demographics;
- Views on attraction and retention;
- Views on industry and career challenges.

Almost 1,400 young people responded to the survey, creating a representative indicator of their opinions of the oil and gas industry.

Demographics

The survey attracted a very diverse range of respondents. Of the 1,358 participants, 581 – or 42.8% – were female. Geographically, 40% of the respondents came from North America, followed by about 20% of respondents from both Asia and Europe. The remaining percentage of participants was split almost equally between South America, Africa and Oceania (6%, 4% and 4% respectively). Furthermore, 2% of responses were received from the Middle East.

With regards to educational background, most participants have an engineering background (47%), followed by a background in business (33%), or science (18%), and 2% of participants have a background in law.

Attraction and retention

Almost all survey participants would recommend a career in the petroleum industry and more than half of the participants intend to stay in the industry throughout their career. While the strongest

motivation for joining the industry globally was the income potential, there were small but statistically significant regional nuances around fast career advancement, opportunity to travel, a strong interest in the field, and the opportunity to work in a high tech environment.

In regard to improving attraction and recruitment to the industry, young professionals worldwide think a stronger focus on work-life balance is important. Almost equally important, albeit again with small regional variances, are closer and earlier ties with universities and a better definition of possible career paths. Women around the world suggest that a focus on the oil and gas industry providing men and women with equal opportunities is an essential way to improve recruitment in the petroleum industry. Improvement suggestions for retention were similar to the suggestions to improve recruitment – there was a strong focus on the compensation package, work-life balance, and career path definition.

Industry and career challenges

Interestingly, 70% of the young people surveyed believe that environmental concerns are one of the biggest challenges. This view is held across gender, across regions and is also irrespective of educational background. Across the regions, the percentage of youth indicating environmental concerns as a challenge ranges from 62% of European men to 84% of South American women and African men.

Respondents, regardless of gender, are critical about both the industry's messages in the media (27% don't think that the industry has appropriate messages in the media) and the industry's use of social media (only 30% think that the industry uses



◀ Students on a fact-finding trip to Gazprom production facilities in Orenburg. Forging closer ties with universities is seen as important to attracting young professionals.

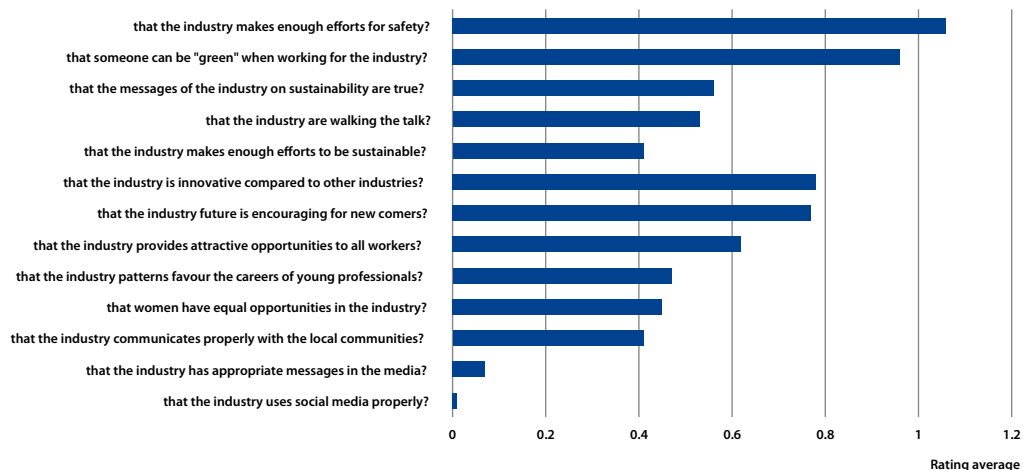
social media properly). The industry's outreach to the public gains the lowest approval rating from the young respondents ahead of its commitment to sustainability, equal opportunities for women and engagement with local communities.

Looking at challenges facing the oil and gas industry, North America stood out, rating negative public perception as a bigger problem than respondents from other regions. Of the North Americans, 76% consider bad public perception a

challenge, while the South American region was the least concerned with only 34% naming public perception as a challenge.

Moving to the challenges the individuals will face during their careers, environmental concerns feature highly alongside concerns about the industry's ability to adapt to a changing environment. Some 56% of young people surveyed indicated that they expect to face challenges around environmental concerns, while 59% expected chal-

Do you think...





▲ The Oil Sands Leadership Initiative's Future Forests programme has planted over 1.6 million trees. Environmental concerns about the industry featured highly in the youth survey.

lenges as regards the industry adapting. Looking at gender issues, 45% of women expect to face gender related or other barriers, while only 11% of men have the same expectation. Men on average agree (only 17% against) with the statement that women face equal opportunities in the industry, while women are more critical (36% against) about it. Work-life balance features strongly on a universal level. Globally 59% expect "family and work-life balance" to be a challenge. Women are slightly more concerned than men, as 62% of women and 57% of men view balance as a challenge. There are some differences by region, as the concern varies from 44% of Asians to 63% of Europeans.

One might expect that the concern about the bad public image is felt on a personal level when

young professionals join the industry. Surprisingly, this is rarely the case. The strongest negative reaction is received in North America with 7%, in Asia the least (less than 1%). The negative reactions seem to revolve around two general topics, environmental concerns on the one hand and personal integrity or "selling out by working for big oil" on the other hand.

Generally the experience of young professionals seems to be that some of the initial negative reaction could be countered by giving more realistic information about the oil and gas industry and also by highlighting that the best way to change something is from within.

The notion of a role for young professionals is also supported by the fact that less than 10% view "no opportunities for new generations" as a challenge. Phrased differently, young professionals believe there are many opportunities for new generations.

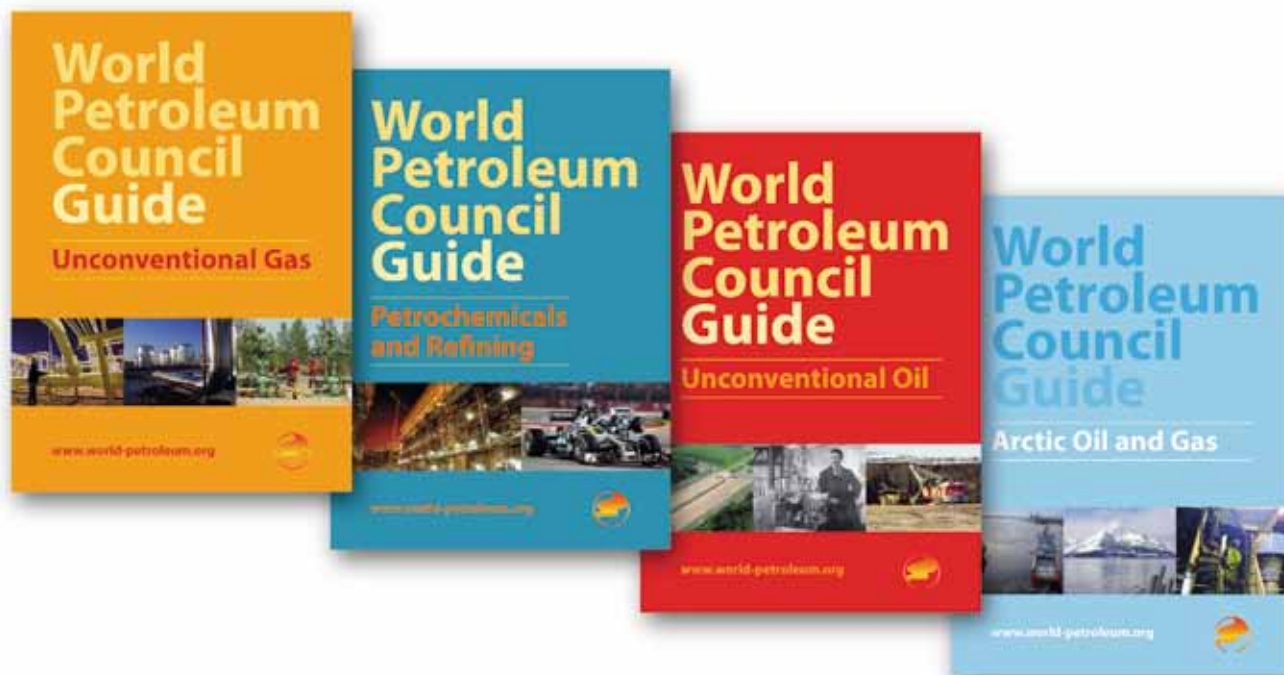
Conclusions

Young professionals around the world feel environmental concerns are perceived to be the biggest challenge for the industry overall but also for their own careers. On a personal level work-life balance features strongly around the world as well.

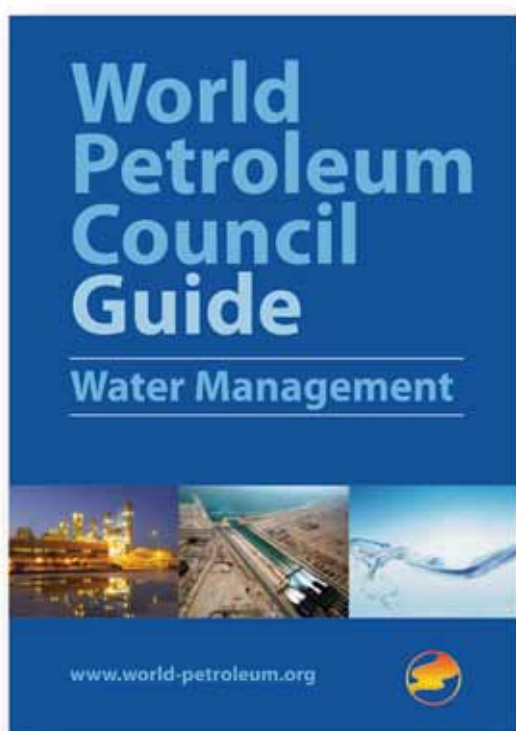
Women do not necessarily enjoy equality of opportunity with men. While believing that diversity or safety are being addressed, young professionals do not think the oil and gas industry sends the right messages to the media and its presence is not sufficient on social media either.

While young people see many opportunities for future generations, they seem sceptical as to the ability of the industry to adopt the necessary changes. For recruitment and retention, high earning potential remains important and an additional focus on work-life balance is desirable.

Katharina Gruenberg is an Economist for Shell Global Solutions and she is the WPC Youth Representative for the UK. Csaba Zsótér is Head of Feedstock Supply and Trade for MOL Group and he is the WPC Youth Representative for Hungary.



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Future prospects for Angola's oil and gas production

Angola's wide-ranging oil and gas plays have great potential to achieve economic and energy security.

By Tako Koning



The oil and gas plays in Angola range from the pre-salt to the post-salt and include Tertiary clastic turbidite reservoirs, salt-raftered Cretaceous Pinda carbonates, and pre-salt microbialitic carbonates similar to Brazil's giant Tupi oil discovery. These wide-ranging, high potential plays have led to a dramatic surge in Angola's oil production. A decade ago, Angola was producing approximately 750,000 b/d and now production of almost 2 million b/d has been achieved.

Angola is the second biggest oil producer in Africa after Nigeria, which currently is producing about 2.2 million b/d. Due to Angola's highly favourable petroleum geology, within the next decade Angola is expected to replace Nigeria as Africa's top oil producer.

Historic milestones

The history of Angola's petroleum industry is extensive and events over the last 60 years in particular

have shaped the industry today. The first milestone occurred in the late 1700s when the Portuguese colonialists discovered oil seeps and asphalt deposits at Libongos, about 60km north of Luanda, and shipped some of the oil to Lisbon and Rio de Janeiro to be used as a caulking material to keep ships watertight. Libongos is located on the eastern edge of the Kwanza Basin within 500m of outcrops of Pre-Cambrian granites.

The year 1915 marked the next important milestone when the Portuguese oil company, Companhia de Pesquisas Minerais de Angola, carried out the first drilling for oil in the valley of the Dande River, near the coastal village of Barra do Dande. The drill site was about 40km northeast of Luanda. One of the wells, Dande-4 drilled in 1916, was tested at just 6 bpd and was abandoned but it signified the first flow of oil in Angola. Drilling for oil in the onshore Kwanza Basin continued sporadically for the next 40 years with no commercial success until 1955, when

▼ The FPSO constructed to work the Kizomba A project in Block 15, offshore Angola was, at the time, the largest in the world.





the Benfica-2 well, just south of Luanda, resulted in the country's first commercial oil discovery.

The oil was found in a salt-rafterd block of Cretaceous-age Pinda carbonate. The field went into production in 1956, representing the beginning of oil production in Angola.

Angola's long civil war, which lasted from independence in 1975 until 2002, slowed down onshore exploration, so international companies focused on offshore operations during that time. However, Angola's sedimentary basins are almost entirely offshore with only small extensions onshore. Consequently only a small quantity (10,000 b/d) of Angola's oil production is from onshore sites.

The first offshore oil field in Angola, Malongo, was discovered in 1968 in the Angolan province of Cabinda by the American company, Cabinda Gulf Oil Company. Chevron bought Gulf Oil in the early 1980s and the company is still operator of two blocks, now producing about 500,000 b/d.

In 1996, Angola was producing about 700,000 b/d when another historic event happened – the French oil company, Elf Petroleum, discovered the Girassol oilfield in 1,300m of water, about 140km off the coast of Angola. The discovery of Girassol stunned the oil industry since finding oil so far off the coast and in a new geological formation was totally unexpected.

Additional drilling by Elf proved Girassol to be a significant oilfield, with the oil-bearing reservoir located in sandstones and conglomerates of Oligocene age (25 million years old) which were deposited as turbidites. This led to many more such discoveries in deposits dating back to the Oligocene and Miocene (15 million years old) ages in the deep waters of Angola. Companies which are involved in this include Chevron, Esso, Maersk, Total, BP and the state oil company, Sonangol. As a result, about 75% of Angola's production now comes from such reservoirs.

Had Girassol and the follow-up fields not been discovered, Angola would have remained a modest oil-producing country with production of only about 500,000 b/d – but now it is an important one.



The impact of Brazil on Angola

The discovery of the Tupi oilfield in Brazil in 2007 was a historic event for Angola. Tupi was drilled by Petrobras in the deepwater part of the Santos sedimentary basin - the water depth was 2,100m. The well was drilled about 5,200m below the sea floor. The total drill depth of the well was 7,300m. It had many mechanical problems and the final cost was \$240 million.

But the costs were justified by the results. Tupi is estimated by Petrobras to hold more than 6 billion barrels of recoverable oil reserves in the high-pressure, high-temperature environment beneath a massive (2km) salt sheet. Tupi, now renamed Lula after Brazil's former President Lula, was the first of the now famous pre-salt oil fields in Brazil.

Lessons from Tupi have helped Angola. The Tupi discovery proved that a working petroleum system exists beneath the salt layer of the Santos Basin. The oil source rocks are organically rich lake shales, the reservoirs are lacustrine beach sands, porous limestones and dolomites known as microbalites, and the seal above the reservoirs, which keeps the oil trapped, is the thick, impervious salt layer.

Since the discovery of Tupi, many more pre-salt oil and gas fields have been found in the Santos Basin as well as in the more northern Campos Basin. Oil industry analysts, such as Wood Mackenzie and

▲ FPSO Cidade de Ilhabela in the pre-salt Santos Basin offshore Brazil. Discoveries in Brazil's Tupi and Santos Basins are important for Angola as the country's Benguela and Kwanza Basins were adjacent to the Brazilian deposits when they formed.



The impact of the pre-salt discoveries on Brazil is dramatic. Brazil's oil production is now at a record 2.2 million b/d, of which about 700,000 b/d is from the pre-salt. Petrobras believes that output from the pre-salt reserves will grow and bring Brazil's per-day oil output to at least 4 million barrels, nearly double current production.

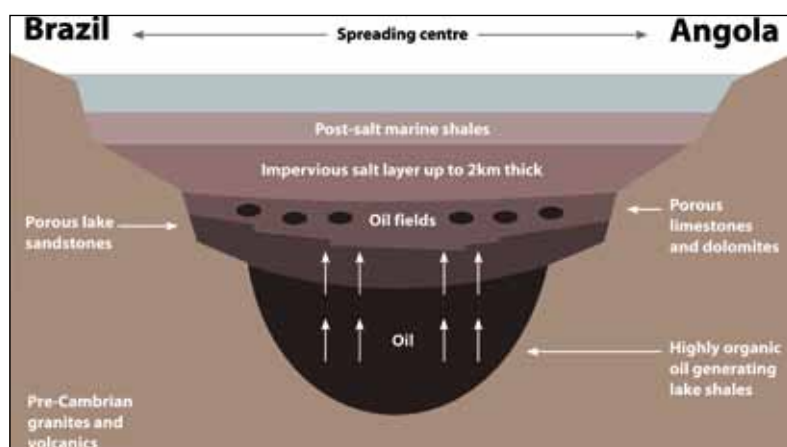
When the conjugate margins of Angola and Brazil are juxtaposed or reconstructed to the time of the initial opening of the south Atlantic, about 140 million years ago in the early Cretaceous age, this clearly shows that the Santos and Campos Basins were located adjacent to Angola's Benguela and Kwanza Basins. Accordingly, the success of the pre-salt operations in Brazil could be repeated in Angola's deepwater areas where drilling in the pre-salt has been negligible before 2011.

More history is made

As a result of investigating the southern Atlantic conjugate margins, a historic event for the Angola oil industry occurred in December 2011, when 11 deepwater to ultra-deepwater blocks in the Kwanza and Benguela Basins were awarded by Sonangol to a number of operators including BP, Cobalt, Repsol, Total, Eni, ConocoPhillips and Statoil. Non-operators with working interests included Sonangol and China-Sonangol. Statoil obtained the lion's share of these blocks with two operated blocks and non-operated working interests in three other blocks.

In January 2012, Maersk announced that the Azul-1 well in deepwater Block 23 was the first well to penetrate pre-salt objectives in the Angolan deepwater. The well was drilled in a water depth of 920m and reached a total depth of 5,330m. The press release from Maersk stated that "the preliminary interpretation of the data indicated a potential flow capacity of greater than 3,000 bpd. We are encouraged by the results of our first pre-salt exploration well in this region, which was also the first ever deepwater well targeting pre-salt reservoirs in the Kwanza Basin".

In February 2012, Cobalt International Energy (CIE) announced the results of its Cameia-1 well,



▲ Though millions of years of continental drift now separate them, Angola and Brazil's shared geological heritage means that discoveries and technical developments in the one provide important lessons for the other.

IHS, have estimated that the oil reserves in Brazil's pre-salt reservoirs could amount to some 20 to 30 billion barrels of recoverable oil. ANP, which is Brazil's government oil industry regulatory agency, has been quoted that the reserves to be up to 50 billion barrels.

drilled in 1,680m of water in deepwater Block 21, again targeting the pre-salt section. Cobalt reported that the well confirmed the presence of 360m gross continuous oil column with a net-to-gross pay estimate of more than 75%. No gas-oil or oil-water contact was evident on the wireline logs. An extended drill stem test was performed at Cameia-1 which flowed at a sustained rate of 5,010 b/d of 44° API oil and 14.3 million cubic feet per day (400,000 mcm/d) of associated gas with limited drawdown. Cobalt also stated that the well has the potential to produce in excess of 20,000 b/d.

The future for Angola and beyond

Based on more than 40 years of experience in the oil industry, I expect the Angolan oil industry will remain vital for many more years. Already, two-thirds of Angola's oil production is from deepwater operations and, unquestionably, more Oligocene and Miocene oil discoveries will be made in ultra-deepwater areas. Based on the drill results of Maersk's and Cobalt's wells, pre-salt plays suddenly look very promising.

Could the dramatic increase in production seen in Brazil, as a result of the discovery of the pre-salt oil, happen to Angola? Based on the success of Maersk and Cobalt, it is possible, although much more drilling is needed. Indeed, could the results of Brazil's pre-salt plays be repeated elsewhere in West Africa?

In 2012 and 2013, in the deepwaters of Namibia, five exploration wells were drilled unsuccessfully by multiple operators, including Petrobras, BP, and HRT Oil & Gas, in the hopes that the pre-salt play extended there. On the other hand, in 2013, Total as operator and Cobalt and Marathon as minority partners, drilled in deepwater Gabon. The Diamante-1 exploration well was drilled as Gabon's first-ever well targeting a deepwater pre-salt prospect. Encouragingly, this well, drilled in 1,729m of water to a depth of 5,584m, encountered 50-55m of gas and condensate. The well was temporarily abandoned pending further analysis of the data.

Another milestone in Angola's petroleum industry happened in July 2013, when the LNG plant at Soyo, in northern Angola, commenced production at 5.2 million tonnes per year. On an energy-equivalent basis, this amounts to about 200,000 b/d.

A strong demand exists for Angola's natural gas due to the increasing consumption of LNG in Asia and Europe, where countries are seeking to diversify sources of LNG. In addition, as gas becomes increasingly the preferred fuel of the future, there will be much focus in Angola on its minimally explored gas potential.

Additionally, the oil industries of Angola and Canada have much in common. For both countries, the oil industry provides the government with much needed revenue via royalties and taxes. Indeed, Angola is very much a petro-economy where the oil industry provides 95% of the country's foreign exchange. For geoscientists, both countries are very interesting and challenging work-wise since oil industry professionals can work on an enormous variety of plays, both onshore and offshore.

In Angola, reservoir ages range from Cretaceous to Tertiary, whereas in Canada the reservoirs are as old as Devonian and as young as Tertiary. With both countries, the oil industry is long term, not short term – the industry in both countries is not anywhere close to being “played out”. Both countries have much unexplored geological potential and the use of technology such as horizontal drilling, hydraulic fracturing, 3D & 4D seismic, and secondary recovery will ensure long-term, bright futures in the oil industry for both countries.

Tako Koning, P.Geol, is Senior Petroleum Geologist and Business Development Manager for Gaffney, Cline & Associates (www.gaffney-cline.com) in Luanda, Angola. This is an updated version of a presentation he gave at GeoConvention on May 12, 2014. Geoconvention is a conference held annually in Calgary, Canada by the Canadian Society of Petroleum Geologists, Canadian Society of Exploration Geophysicists and Canadian Well Logging Society.

The role of the European refining industry in developing cleaner fuels

Petroleum will continue to play a significant role in fuelling Europe with products constantly improving.

By Chris Beddoes



Affordable mobility has been at the heart of Europe's story over many years, allowing the freedoms created by the European project to be translated into reality. The free movement of people across Europe for work and leisure, as well as goods traded in the EU internal market, has allowed economic growth and enriched Europe socially, supporting the reunification of Germany and the enlargement of the EU to its current 28-country membership.

Petroleum products have fuelled this affordable mobility and will do so for many years, until technology breakthroughs find economic substitutes. Four people can drive in comfort the 800km from Berlin to Brussels for less than €10 each in fuel costs – and half of this is tax. As well as affordable personal transport, goods are transported cost-effectively around Europe and the world.

In the EU, two-thirds of the production barrel goes to transport, with the balance for petrochemicals, special products and diminishing heating demand (oil is being used ever decreasingly in electricity production in Europe).

But oil is unique as a primary energy source as it needs to be transformed into petroleum products to be useable by consumers. This is the role of refining. As the industry has responded to the demand for improved and cleaner products, with tougher technical requirements of products and increasingly stronger competition, refining has grown ever more sophisticated and technology-driven.

Petroleum-refined products remain the leading energy source for transportation fuels.

Our European industry shares many characteristics with refining around the world: the crude market operates globally, all refineries are energy-intensive, technology is widely available through licensors, and products can be traded globally.

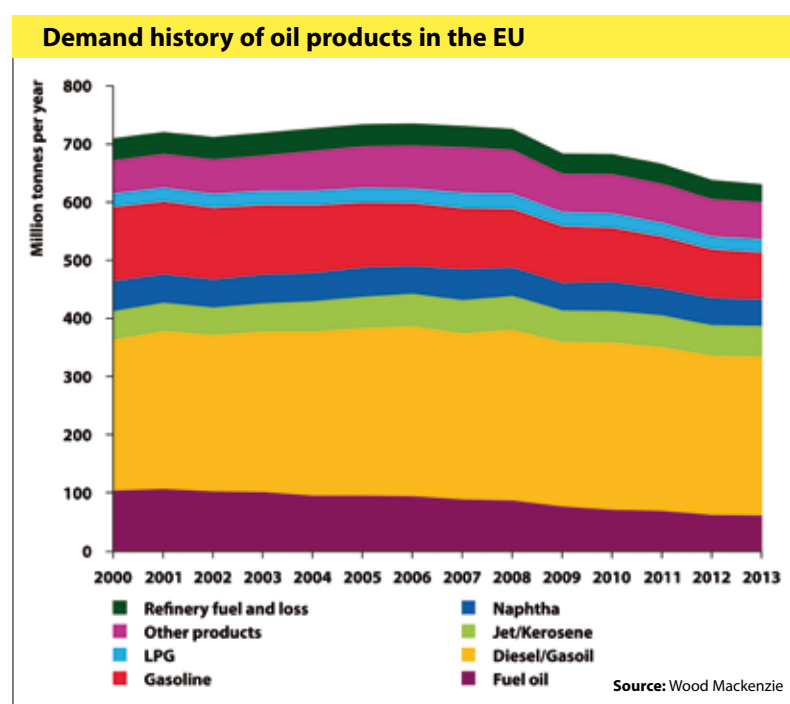
But each global region has unique characteristics, driven by its market for products, government policy and legislation, and the history of its refining sector.

The European market for transport fuels is primarily supplied by petroleum-refined products which represent more than 90% of the energy needed. According to the IEA and most specialists, petroleum-refined products will continue to be the leading energy source for transportation fuels for at least the next 25 years.

The impact of diesel

Increased use of diesel fuels for transport has been accentuated by European taxation policies. Historically, European refineries developed in the 1960s and 1970s with many fluid catalytic crackers built

▼ Figure 1.



to produce gasoline. In 1990, gasoline demand was 30% higher than that for diesel; but by 2010, diesel demand was twice gasoline demand, creating a dramatic swing in the output needed from refineries.

EU fuel demand slowly increased for many years until a significant fall in total demand occurred during 2008 as a result of the economic crisis. Now, the decline in gasoline consumption is continuing, while demand for distillate enjoys continued growth, from diesel driven cars and freight growth on road, sea and air. This demand structure has resulted in a growing trade imbalance: more than 30% of the gasoline manufactured in the EU has to be exported, while the EU relies on about 15% imports of diesel and 35% for jet fuel.

In this respect, the EU has a very different market structure from the rest of the world. Long history of diesel-oriented taxation has largely driven this continued and growing imbalance, resulting in a competitive squeeze for EU refining.

EU refining has therefore had to find export markets for its gasoline surplus. Since the late 1980s, the US market has been the primary partner for EU gasoline exports but EU refineries are now facing falling US demand and strong competition – not only in the US but also in other markets. This competition comes from US East Coast refineries following the recent shale revolution and other Asian and Middle Eastern export refineries.

Moreover, although there are examples of significant investments around Europe, such as Total and ExxonMobil's 2013 investments in refineries in Antwerp and ExxonMobil's 2014 investment in Norway, the European refining sector has not been able to justify enough investment to meet this changing EU demand profile.

EU: A worldwide leader in refining technology innovation

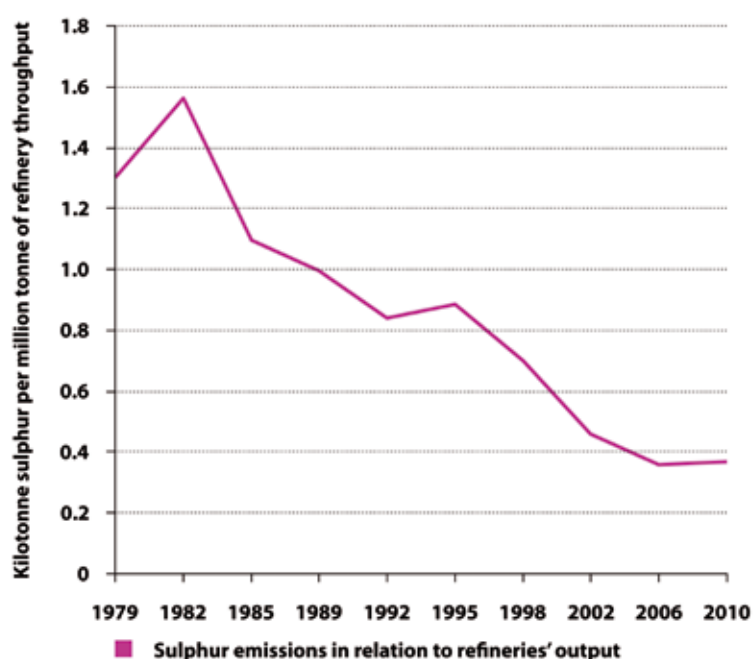
The strong capacity of the refining industry to innovate has enabled the continuous development of cleaner fuels and the setting of worldwide standards for transportation fuels.

The story of cleaner fuels has been going on for many years but it accelerated with the phasing out of lead and benzene from all EU gasoline by 2000. It was recognised that advances in refinery technologies would be required to reduce and then eliminate lead and benzene from gasoline while maintaining satisfactory octane quality for gasoline vehicles. Eliminating lead as an octane-improver required refineries to engineer new ways to increase the production of unleaded gasoline having a higher "natural" octane.

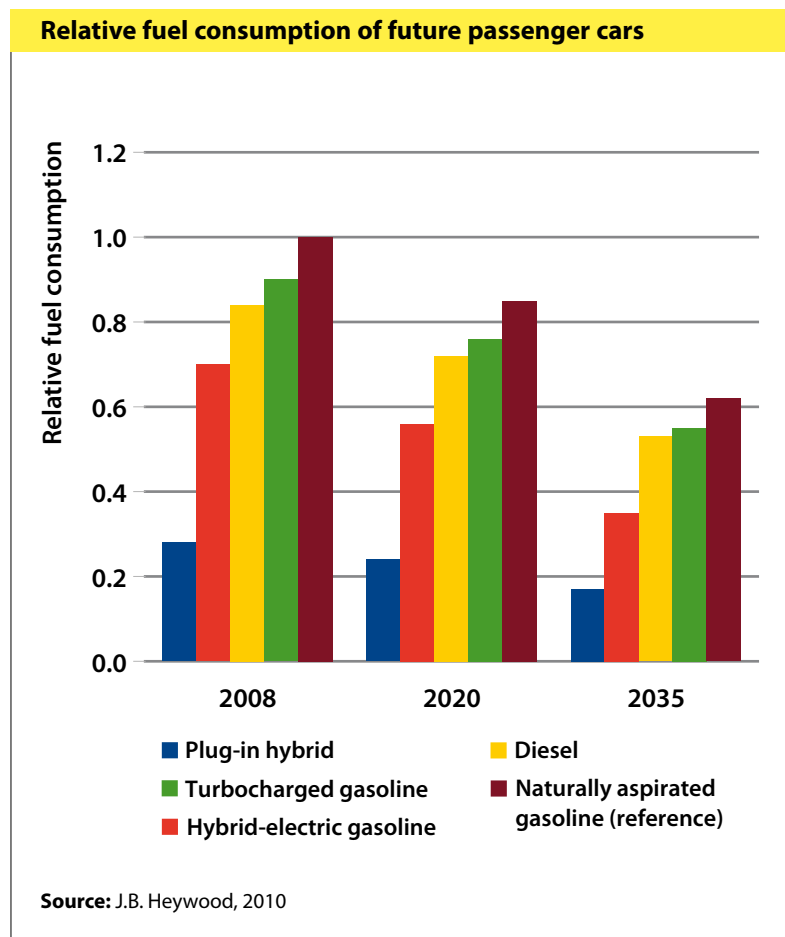
These improvements in new process units and catalysts resulted in major investments and greater energy and hydrogen consumption. To find the best balance between refinery production of unleaded gasoline and vehicle performance, a major collaborative study was completed in the 1970s and 1980s by the refining and automotive industries to determine the optimum research and motor octane levels accounting for both vehicle performance and refinery operations. CONCAWE, the refining

▼ Figure 2.

Reduction in sulphur emissions from refineries in relation to refinery output 1979-2010



Source: Concaawe



▲ Figure 3.

industry's scientific and technical organisation, released "Rational Use of Fuels In Private Transport", a study which provided the technical basis for the determination which established 95 RON (research octane number) as the standard for European gasoline, still in place today.

Impressive reductions in tail-pipe emissions limits have been achieved for different vehicle types, particularly over the past 25 years. Changes in fuel specifications have played a major role in enabling these reductions, starting with lead elimination. This was followed up by the removal of all sulphur from gasoline and diesel fuels.

Major investments in the refining industry were required to achieve the removal of sulphur from road fuels, starting in the 1980s. This enabled the introduction of the first generation of cars equipped with emissions after-treatment systems, initially oxidation catalysts containing precious metals. The

new cleaner fuels allowed these catalysts to reduce the concentrations of hydrocarbons and carbon monoxide in engine exhausts and initiated major advances in after-treatment technologies that are still occurring today.

Is there still room for more improvement to produce cleaner fuels?

The development of ever cleaner transport fuels is an ongoing objective for the EU refining industry, for road fuels in particular. This is driven by close collaboration with the automotive industry and requires continued R&D and plant investments.

Cleaner fuels such as clean diesel contribute to a three-part system that combines sulphur-free fuels, advanced engines and effective emissions control technology. This system ensures that petroleum-fuelled engines will continue to play a strong role in the future, while helping meet energy security, greenhouse gas and clean air objectives around the world. Although since 1992, the EU has introduced increasingly stricter limits on vehicle emissions through a series of Euro standards, meeting these standards has only been made possible by innovation and advances in vehicle and refining technology.

The latest and most stringent standard, Euro 6, will bring the cleanest cars ever produced on to the roads. Over the last 15 years, NO_x limits for diesel engines have been reduced by 84%, and particulates by 90%.

Modern vehicles achieved around 123.4 gCO₂/km in 2014 (below the 130 gCO₂/km target for 2015); by 2021 this will reduce a further 25% to 95 gCO₂/km. Tailpipe emissions of SO_x are largely eliminated and Euro 6 standards have reduced significantly particulates and NO_x.

Issues with petroleum alternatives.

Mandated alternatives to petroleum products are struggling to be competitive. In the early 2000s, biofuels were considered as a potentially attractive alternative to petroleum products for transport, achieving greenhouse gas emission savings and

reducing the reliance on imported oil. However, much has been learned about the environmental and societal impacts and contributions of first generation biofuels. The fact that their impact on food prices and availability and greenhouse gas reduction benefits are much less than expected has raised major concerns about their true merits. These concerns were outlined in a 2014 EU Joint Research Centre report, “EU Renewable Energy Targets in 2020: Revised Analysis of the Scenarios for Transport Fuels”

Furthermore, while public authorities have largely mandated biofuels, they still need to subsidise their use to reach even a 5% share of energy for transport.

Similarly, electrification of light duty transport is also slow to develop, notably having to overcome the disadvantages of affordable batteries with sufficient range.

Internal combustion engines (ICEs) still offer significant potential for energy efficiency improvements, with very low tail-pipe emissions. Diesel ICEs are already extremely efficient but gasoline technologies offer perhaps the biggest fuel consumption reductions for the next 20 years (30%-50%). Both technologies, when allied with energy recovery systems, partial electrification through hybrids and weight reductions, offer the most cost-effective efficiency gains and greenhouse gas reductions in the foreseeable future.

What is needed to successfully develop new cleaner transport fuels?

We believe that a number of principles should be applied to allow new technologies to develop and become long-term solutions for fuelling transport at the lowest cost to the consumer, to the economy and to European society as a whole.

Firstly, technology neutrality is needed to allow various technologies to compete through market-based mechanisms. This is most likely to achieve cost-effective, flexible and economically sustainable solutions.

Secondly, the search for greenhouse gas savings must look at the entire life cycle of the fuel from

well to wheels. Savings in vehicle tail-pipe emissions can be considerably reduced when the fuel production emissions are considered. This is the case with electricity supplies in the EU, for example – if the electrons are derived from sources that are not wholly renewable, such as coal, it means EU electricity has a long way to go to become truly emissions free.

Thirdly, supporting R&D to search for new technologies makes a lot of sense, but before large sums of public money are invested in promoting large scale experimentation, we must be sure to understand the development and potential side-effects. Let's learn the lessons from the past: the land use change, food competition and costs of first generation biofuels are an example. We should think through and understand how we will manage the life cycle costs of, for example, electric vehicles and their battery components (such as lithium, originating from very few sources). Costly infrastructure mandates now may not support the most cost-effective long-term technology.

Although EU refining has evolved significantly to meet the needs for cleaner fuels, it still needs to adapt to changing market demand, principally in Europe, if it is to remain competitive. For the lowest societal cost, market demand should adjust based upon the principles above and, in particular, letting exponents of affordable technology develop fuels on their real merits. EU refining needs a predictable and competitive policy framework to be able to continue to invest in the new technologies to meet future market demands and to compete internationally.

In conclusion, EU refineries in partnership with vehicle manufacturers over many years have delivered both efficiency gains and cleaner transport in Europe. As a result, Europe has led the way in setting standards for other parts of the world. EU refining can provide the clean fuels to continue this affordable mobility if the economic and policy framework remains competitive and predictable.

Chris Beddoes is the former Director General of Fuels Europe (www.fuelseurope.eu).

US unconventional energy development and the use of industry standards

The shale gas revolution has been a major factor in updating standards for the hydrocarbons industry.

By J. Gerardo Uría



Over the last five years, nearly every barrel of new US hydrocarbons production can be attributed to shale energy accessed through the use of horizontal drilling and hydraulic fracturing.

According to a recent study by ICF International, US oil production from wells utilising horizontal drilling and hydraulic fracturing totalled 4.78 million barrels per day in 2013, accounting for 48% of all US production – up from 11% in 2008.

Not coincidentally, US production, according to the Energy Information Administration (EIA), rose from 5 million barrels per day in 2008 to 7.4 million in 2013 – also an increase of 48%.

Today, US production is over 8.5 million barrels per day, 70% higher than the 2008 average.

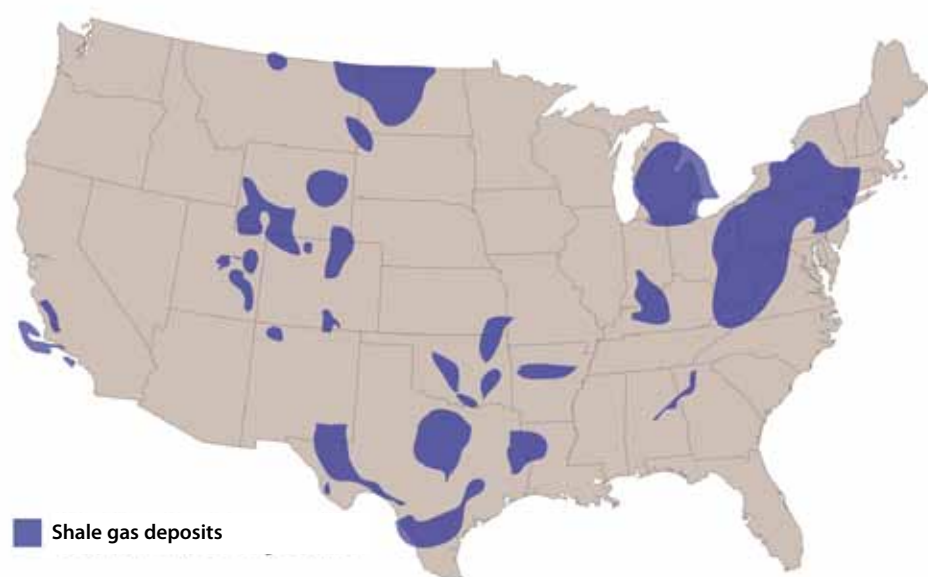
This production growth has counterbalanced global supply disruptions that would once have sent

gasoline prices soaring. Prior to the decrease in fuel prices, EIA Chief Adam Sieminski estimated that 2014 had the potential to be another expensive year for US consumers, with global supply outages adding up to about 3 million barrels per day. Without new American production, he speculated that prices would be about \$150 per barrel – consistent with ICF estimates.

Instead, per barrel costs dropped well below \$100, translating to a 60¢ drop in the price of a gallon of gas by the end of 2014, which had the equivalent impact on the United States economy of a one-time tax cut of between \$100 billion and \$125 billion, according to a Goldman Sachs economic analysis.

Another study estimates that for every 1¢ drop in the retail price of gasoline for a year, American consumers save \$1.2 billion. Beyond prices at the

Shale gas deposits in the US



pump, American families and businesses are reaping significant economic benefits from the shale energy revolution. One study found American households enjoyed an average \$1,200 increase in disposable incomes in 2012 due to higher household wages and lower costs for energy and energy-intensive products. That should grow to \$2,000 this year and \$3,500 by 2025.

Availability of affordable energy from shale has also spurred a manufacturing renaissance, supporting nearly 400,000 manufacturing jobs this year, or 3.2% of all US manufacturing jobs (IHS Economics), projected to rise to more than 500,000 in 2025. According to an IHS study, US public elementary and secondary school districts saved approximately 9.3% on electricity costs and 21.3% on natural gas costs during the 2012-2013 fiscal year, for a total of \$1.2 billion – enough to employ over 14,200 teachers. State and local governments saved an estimated 9.5% on electricity and 21.6% on natural gas for a total saving of \$720 million – all due to shale energy.

The full unconventional value chain supported more than two million jobs in 2012 and is projected to support nearly 4 million jobs by 2025. These jobs

are increasing in areas of the country where oil and natural gas exploration does not have the same history as Texas or Oklahoma. Expansion of hydraulic fracturing into new areas has prompted a heightened focus on community engagement, which is exemplified in the release last summer of API's first-of-its-kind community engagement standard. These guidelines will provide a roadmap for oil and natural gas operators seeking to build lasting, successful relationships with local residents in areas of the country where energy development opportunities are open for the first time, thanks to advances in horizontal drilling and hydraulic fracturing.

In areas like North Dakota, for example, the economy is flourishing and local operators are working diligently to ensure newly opened resources are developed in conjunction with community goals. API's new standard, created in conjunction with the American National Standards Institute (ANSI) is designed to share those lessons with operators around the country.

Dubbed ANSI/API Bulletin 100-3, API's community engagement guidelines will serve as a gold standard for good neighbour policies that address community concerns, enhance the long-term

▼ Tapping North Dakota's reserves has boosted the local economy and operating practices are being shared across the country.



benefits of local development, and ensure a two-way conversation regarding mutual goals for community growth. The standard provides a detailed list of steps that oil and natural gas companies can take to help local leaders and residents prepare for energy exploration, minimise interruption to the community, and manage resources.

Standards for the five phases of development

The document is divided into the five phases of oil and natural gas development: entry, exploration, development, operations and exit.

During the entry phase, companies determine the potential for energy extraction in a given area. They are encouraged to introduce important personnel to local leaders, share information on safety commitments and operational goals, and set professional standards for local employees and contractors.

In the next phase, during exploratory drilling, companies are encouraged to focus on transparency, open dialogue, and education, with recommendations for community meetings and discussions around training for job opportunities.

In the development phase, as operations are expanded to match the potential of local resources, companies are urged to work with local emergency

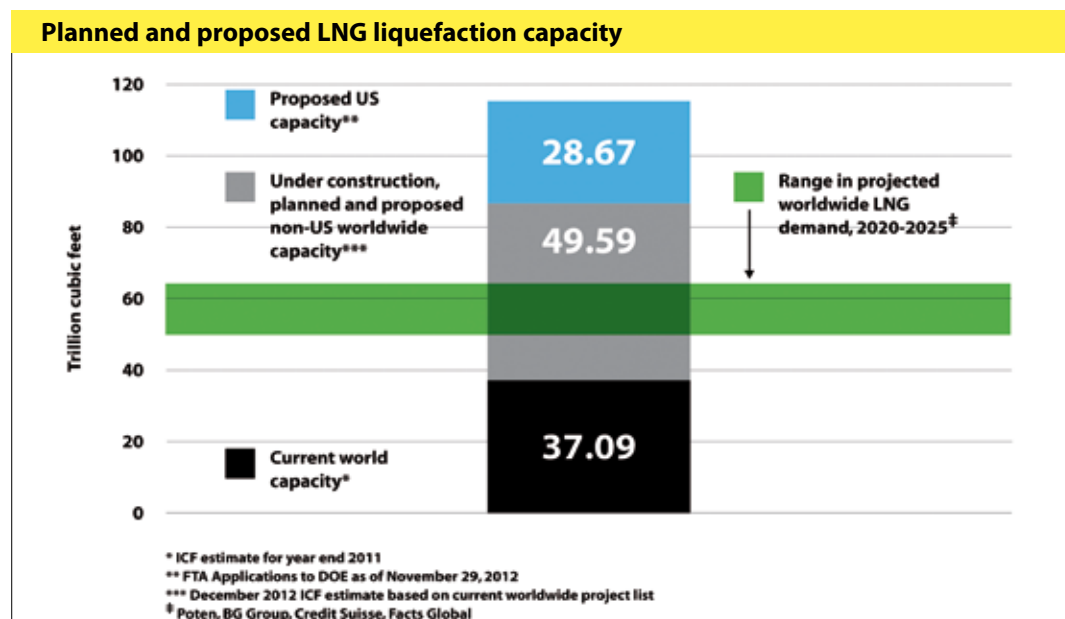
responders to prepare against any potential risks. They also are prompted to engage with local authorities, develop relationships with mineral owners, and promote best practices regarding safety and environmental protection.

During the operations phase, industry presence declines, as existing wells continue to produce, while the land impacted by development and exploration is reclaimed and restored. Long-term standards for maintenance and traffic safety are recommended, as well as a public feedback mechanism that allows local residents to maintain two-way communication with company representatives.

Finally, during the exit phase, companies may close or transfer ownership of local operations, sometimes after decades of successful production. Just as companies plan for their original entry, it is recommended that they engage with the community regarding plans for reclamation and restoration, and prepare stakeholders for the transition.

Flexibility within the standards

Each community is different, and the standards are not designed to be exhaustive, but rather to serve as a reference for developing a plan-of-action that matches the needs and concerns of a broad range of stakeholders – from rural farmers to indigenous tribes.





API first began publishing standards in 1924. Developed and managed by industry and academic experts, API's certification and standards program is accredited by ANSI, the same body that accredits programs at several national laboratories.

The community engagement standard expands the portfolio to reflect best practices and proven models that have been developed by industry participants over decades of successfully building mutually beneficial relationships with communities across the nation.

Hydraulic fracturing is a proven, safe technique that has been used since 1949 in over one million wells in the US. As a result, America is now the number one producer of natural gas in the world, and by later this year, it is expected that we will take the top spot in crude oil production.

Besides local opportunities and economic benefits, the shale-driven energy prominence has global implications. Our status as a world energy leader affords significant economic and geopolitical opportunities through exporting a portion of our abundant domestic liquefied natural gas (LNG) supplies to friendly nations.

Projected world demand (in 2020-2025) for LNG is 50-65 tonnes per day. However, 37 tonnes per day already exists. That leaves only 13-28 tonnes per day of additional supply needed to meet worldwide demand for LNG.

In the US, projected LNG exports would represent less than 8% of projected US consumption and less than 2% of EIA's estimates of the US total natural gas resource base.

The implication is clear: US energy resources are more than sufficient to supply domestic energy needs as well as serve world markets. Nationwide, LNG exports would contribute up to 452,000 jobs between 2016 and 2035 and add up to \$73.6 billion annually to the GDP, according to an ICF International study.

The impact of American-produced shale energy has been a game-changer – both for the US economy and world energy markets. The extent to which we maintain and build on our success relies on policy choices.

J. Gerardo Uría, is the Director of Membership and Global Industry Services for the American Petroleum Institute (www.americanpetroleuminstitute.com).

▲ The Sabine Pass LNG terminal. Increasing liquefaction capacity will be greatly beneficial to the labour market and add up to \$73.6 billion to US GDP.

FLNG – F is for floating and flexibility

The development of floating LNG – for liquefaction and regasification – is opening up new opportunities for the natural gas business around the world.

By Mark Blacklock

With a price tag of \$54 billion Gorgon LNG is the world's most expensive LNG project and has an unenviable record in cost over-runs, originally being budgeted at \$37 billion. The project involves piping gas from the offshore Gorgon and Jansz-lo fields to a plant on Barrow Island, Western Australia. The first of three liquefaction trains is set to start operations later in 2015.

Building an LNG plant in a remote area means first building the infrastructure: an airport, a port, roads, accommodation, and then ferrying in construction workers and materials. It's an expensive process – even more so in Australia where skilled labour is in short supply due to the large number of LNG projects being developed. In contrast, a floating liquefaction plant can be built in the controlled environment of a shipyard and then towed to the site. This is what will happen when the vessel

Prelude takes up its station some 200km offshore north-western Australia and starts processing gas from the Prelude field in the Browse Basin.

Shell's Prelude LNG was the first floating liquefaction project to get the go-ahead after years of research into the marinisation of processing equipment. The final investment decision (FID) was made in 2011 with the engineering, procurement and construction contract awarded to Samsung Heavy Industries (SHI) and Technip, and the vessel being built to Lloyds Register classification. Inpex, Kogas and CPC joined Shell as partners in 2012 and the vessel was launched at SHI's yard in Geoje, Korea in November 2013. Topsides installation and commissioning is now underway with service entry expected in 2017.

Prelude is the world's largest floating structure with a length of 488m, a beam of 74m and height

► *Prelude* is the world's largest floating structure.



of 94m, and will have a displacement of 600,000 tonnes when all tanks are fully loaded. Once on station a turret mooring system will allow the hull to rotate with the direction of the wind, and the vessel has been designed to withstand Category 5 cyclones and to operate without drydocking for the first 25 years of its expected 50-year operational life. LNG and LPG will be offloaded via a side-by-side vessel configuration using cryogenic loading arms, while condensate will be offloaded from the rear of the vessel using a floating hose arrangement.

The Prelude project will have a total liquids production of 5.3 million tonnes per annum (3.6 LNG using Shell's dual-mixed refrigerant process, 1.3 condensate and 0.4 LPG) compared to Gorgon's 15.6. While Shell has not released financial data, industry observers are putting a \$13 billion price tag on the project, which would give a capital cost of \$2,453 per tonne of annual production compared to \$3,462/tonne for Gorgon (although Gorgon's costs include carbon capture and storage). Moreover, once the Prelude field is depleted the vessel can be moved to another location.

While Prelude was the first floating liquefaction project to reach FID, Petronas FLNG Satu will be the first to enter service with production due to

start in early 2016. It will be followed by Petronas FLNG Dua in 2018. Satu has an annual capacity of 1.2 million tonnes and will process gas from the Kanowit field offshore the Malaysian state of Sarawak. Dua will have a capacity of 1.5 million tonnes and will process gas from the Rotan field offshore Sabah.

Caribbean FLNG was set to be the first floating liquefaction project to enter service this year but the project start-up has been delayed as it will no longer be based in Colombia. This barge-mounted facility has an annual capacity of 500,000 tonnes using Black & Veatch's Prico single-mixed refrigerant technology. It was built by Wison Offshore & Marine in its Nantong yard for Exmar, which will operate it on a tolling basis for Pacific Rubiales under a 15-year contract. Exmar and Pacific Rubiales are looking at various gas fields around the world to employ the barge.

Black & Veatch technology has also been chosen by Golar LNG which is converting the LNG tankers *Gimi* and *Hilli* into floating liquefaction plants with an annual capacity of 2.4 million tonnes. The conversions are being carried out by Keppel Shipyard in Singapore with *Hilli* due for completion in the first half of 2017 and *Gimi* in mid-2018. Golar is finalising negotiations with customers in Cameroon



◀ Caribbean FLNG has an annual capacity of 500,000 tonnes.



▲ Floating regas enabled Argentina to establish the continent's first LNG import facility in just 10 months – Excelsior's *Excelsior* receives a cargo from *Excelsior* in Bahía Blanca.

and Equatorial Guinea for these conversions and has an option on a third.

Regasification

Meanwhile, the floating option for regasification of LNG is gaining momentum as countries around the world appreciate its cost-effectiveness and the relative speed of gaining access to new gas supplies in this way. A typical floating regas terminal with an annual capacity of 5 billion cubic metres represents an investment of around half that needed for a conventional, onshore facility.

Floating regasification was pioneered by Excelsior Energy which developed its Energy Bridge concept when US LNG imports were expected to surge. This is based on a floating storage and regasification unit (FSRU) which receives cargoes via ship-to-ship transfer from an LNG carrier and discharges to the gas grid either alongside a jetty or offshore via a submerged turret loading (STL) buoy.

Excelsior teamed up with Exmar to operate a fleet of purpose-built FSRUs, which can also serve as LNG carriers, and commissioned the Gulf Gateway Deepwater Port offshore Louisiana in March 2005. Excelsior's Northeast Gateway offshore Massachusetts followed in May 2008. The shale boom was to change the US gas trading picture radically, but the flexibility of the concept proved its worth in new markets. Indeed, when Excelsior

decommissioned the Gulf Gateway in 2012 some of the equipment was recycled and used in the company's other projects.

South America and the Caribbean

Floating regas really took off in South America and enabled Argentina to establish the continent's first LNG import facility in just 10 months. To meet a shortage of gas in the peak winter months, Repsol-Stream and YPF teamed up with Excelsior in 2007 to develop the Bahía Blanca Gas Port which began operations in June 2008. Initially a seasonal operation with the FSRU being deployed elsewhere during the summer, it has now become a year-round one. Bahía Blanca was followed in June 2011 by GNL Escobar, 48km outside Buenos Aires, which was developed by YPF and Enarsa with Excelsior.

Brazil also opted for the floating option to start LNG imports and Petrobras worked with Golar LNG on the first phase. Two LNG carriers were converted into FSRUs and based at Pecém, in the state of Ceará (*Golar Spirit*) and Guanabara Bay in the state of Rio de Janeiro (*Golar Winter*). Operations started in 2009.

Petrobras subsequently teamed up with Excelsior to increase import capacity. A short-term charter of *Exquisite* for the Guanabara Bay terminal started in December 2012. Meanwhile, a third terminal was being developed by moving the *Golar Winter* to Baía de Todos os Santos, Salvador, where operations started in January 2014.

In May 2014, *Exquisite* was replaced by the new-build *Experience*. With a storage capacity of 173,400m³, this is the largest FSRU in service but it will be surpassed in late 2016 by a new 263,000m³ FSRU ordered for GNL del Plata.

Uruguay will become the third South American country to introduce floating regas in 2016 when GNL del Plata 4km offshore Montevideo is inaugurated. Gas Sayago is working with Engie (the new name for GDF Suez) and Marubeni on the project which will have an offshore jetty protected by a breakwater. Operations were originally going to

start in 2015 using the *GDF Suez Neptune* as a temporary measure, but construction of the jetty has been delayed by the bankruptcy of the contractor and the project may now start up in late 2016 when the purpose-built FSRU is delivered.

Elsewhere in the region, Colombia and Puerto Rico are nearing FID on floating regas terminals.

Middle East and Africa

Kuwait introduced floating regas to the Middle East to meet peak summer energy demands and Kuwait National Petroleum Corporation worked with Excelerate to commission the Mina Al-Ahmadi Gas Port in August 2009. A new contract with Golar LNG started in March and the purpose-built FSRU *Golar Igloo* is spending nine months a year there.

Dubai in the UAE started LNG imports in 2010 and the Dubai Supply Authority has a contract with Golar LNG to base the converted *Golar Freeze* in the Port of Jebel Ali.

Israel opted for LNG as a temporary solution to a shortage of gas for power generation caused by attacks on the pipeline from Egypt and declining domestic production. Floating regas was the quickest way to tide the country over until volume production from new offshore fields starts. Israel Natural Gas Lines worked with Excelerate to develop a terminal 10km offshore Hadera using the SLT buoy system, which started operations in January 2013.



▲ *PGN FSRU Lampung* was Indonesia's second floating regas terminal and the first to use a tower yoke mooring system.

Jordan too has suffered disruption in its pipeline supplies from Egypt and the Ministry of Energy has contracted the purpose-built FSRU *Golar Eskimo* to start LNG imports in May using a special jetty 18km south of Aqaba.

Meanwhile, Egypt is facing surging domestic gas demand and declining production. Feedstock for the country's LNG exports has been reduced and there is a need for imports. Egyptian Natural Gas Holding Company (EGAS) has leased the purpose-built FSRU *Höegh Gallant* from Höegh LNG and it arrived in the Port of Ain Sokhna, on the Gulf of Suez in April.

Asia-Pacific

Indonesia also faces increasing domestic gas demand and is using some of its LNG production, which



◀ *Golar Eskimo*, seen being fitted out in the Samsung yard in Geoje, Korea, will take up station in Aqaba, Jordan in May.



► OLT Offshore LNG Toscana commissioned the *FSRU Toscana* in December 2013.

was originally dedicated to export markets, to help meet local needs. Two FSRUs are currently in service and more are under evaluation.

Nusantara Regas, a joint venture of Pertamina (60%) and Perusahaan Gas Negara – PGN (40%) contracted with Golar LNG to convert an LNG carrier and the *Nusantara Regas Satu*, in Jakarta Bay, West Java was commissioned in 2012.

PGN went it alone for a second project and contracted a purpose-built FSRU from Höegh LNG, which was also responsible for the tower yoke mooring system, the first time this had been used for an LNG import terminal. Moored 6km offshore Lampung, Sumatra, the *PGN FSRU Lampung* received its first cargo in July 2014.

In October 2013, CNOOC commissioned China's seventh LNG import terminal and its first floating facility. It has contracted the *GDF Suez Cape Ann*, which is operated by Höegh LNG and based in the Port of Tianjin.

The latest countries in the region to opt for floating LNG are Pakistan, where Engro Elengy started imports via the Port of Qasim using Excelerate's *Exquisite* in March, and Bangladesh, where Petrobangla has signed a 15-year deal with Excelerate to use the SLT buoy system offshore Moheshkhali Island in the Bay of Bengal.

Europe

When the UK restarted LNG imports four new terminals were developed between 2005 and 2009, one of which was an Excelerate project. Teesside Gas Port was commissioned in February 2007 but does not have a dedicated FSRU and only receives ad hoc deliveries. Höegh LNG has a new project to develop an import terminal in Morecambe Bay, offshore Barrow-in-Furness. If it gets the final go-ahead the Port Meridian project will start up in 2019.

In Italy, OLT Offshore LNG Toscana commissioned the converted *FSRU Toscana* in December 2013. Moored 22km offshore Livorno, it is operated by ECOS, a joint venture of Fratelli Cosulich SpA (40%) and Exmar (60%).

Keen to diversify its supplies of gas, Lithuania's Klaipėdos Nafta started LNG imports in December 2014 using the new-build *Independence* chartered from Höegh LNG. It is moored in Klaipėda harbour.

Looking ahead

With a large number of proposals on the table around the world, FLNG is set to play an increasing role in the energy business.

Mark Blacklock is the Editor-in-Chief of International Systems and Communications (www.isyscom.com).

FLNG – A game changer for the industry

Petronas FLNG 1 will be the first floating liquefaction facility to enter service at the turn of the year, allowing Petronas to monetise gas fields which previously had zero economic value.

By Datuk Abdullah Karim



Petronas is developing two FLNG projects – a breakthrough approach expected to change the landscape of the LNG business. These allow the company to unlock sources of natural gas which are stranded and still untapped. With the commercialisation of floating LNG, the term “stranded” gas field will eventually cease to exist.

The Petronas FLNG projects are innovative, requiring state-of-the-art technology to address a multitude of technical and operational challenges. Each facility, when ready for start-up, will encapsulate all the required LNG processing and production facilities, personnel accommodation and more importantly, an efficient and HSE-compliant storage and offloading facility that allows for direct

shipping to markets. This is a feasible solution for early monetisation and more agile LNG production; without the need to connect to extensive pipelines or other heavy infrastructure associated with on-shore facilities.

Petronas has pursued the development of its first FLNG facility since March 2012 and it will be moored at the Kanowit gas field, 180km offshore Sarawak by early 2016. Once operational, PFLNG 1 will have a capacity to produce 1.2 million tonnes of LNG per annum.

Realising the value and importance of this project, Petronas then embarked on its second FLNG project, which is expected to be fully operational sometime in 2018. It will be deployed primarily to

► Keel laying for PFLNG 1 commenced in January 2014 at the Daewoo Shipbuilding & Marine Engineering (DSME) shipyard in Okpo, South Korea.





▲ PFLNG 1's hull was launched on 5 April 2014 so that construction could enter the next phase – less than 10 months after the first steel was cut for the project.

develop the Rotan gas field offshore Sabah. PFLNG 2 is designed to produce 1.5 million tonnes a year of LNG.

Design specifications and safety

PFLNG 1 consists of 22 modular systems, which include gas treating, liquefaction, storage and offloading systems, all powered by a 100MW plant. It will use the Air Products AP-NTM all nitrogen recycle process and the liquefied gas will be stored in a dual

row membrane type cargo containment system before being offloaded to LNG carriers. PFLNG 1 is approximately 360m long and the combined weight of both topsides and hull is 132,000 tonnes.

Delivering the project safely is a priority for Petronas. In spite of the myriad challenges, mitigation measures undertaken include comprehensive studies, design optimisations and simulations. One of the technical safety considerations is that PFLNG allows application of robust and cost-effective processing technology. For example, PFLNG uses nitrogen, a non-explosive substance, as a refrigerant and this can be produced on site. PFLNG will also be the first to operate the side-by-side (SBS) loading arm system which has never been applied offshore before. This has been carefully measured via simulation safety studies and model tests to ascertain the operability of SBS mooring for enduring reliability and validating the hull design against sea conditions.

Petronas has also been careful to put in place a more stringent than usual operational system and environmental standards. For instance, the sources of liquid effluents generated by PFLNG are graded as standard A waste water treatment, which is beyond

► The turret for the vessel's external mooring system was installed in July 2014.





the standard B compliance required by the authorities. Moreover, as it is offshore an FLNG plant does not have the environmental impact typically caused by onshore plant construction. This includes land clearing, seabed dredging, soil erosion and water pollution which may affect surrounding local communities.

The next wave

The modular construction of PFLNG helps to ensure precision and reduces contingencies occurring during the construction phase. In addition, the fabrication and construction of the topside modules components were based on the stick build method for safety reasons and to improve efficiency while reducing construction time. To date, PFLNG 1 has surpassed 12 million hours without lost time injury since the project commenced, which reflects the focus of Petronas on safety as an essential and integral aspect of PFLNG development.

PFLNG 1 is nearing completion of the construction phase and PFLNG 2 is just about to commence its first steel cutting. After years of visualising the

floaters on technical papers and drawings, it is now physically ready to set sail.

Drawing on the experience, success and lessons learnt from the PFLNG 1 project, PFLNG 2 has shown remarkable progress.

The priority right now is to prove the technology which Petronas has developed by having the fields in Kanowit and then Rotan commissioned and monetised successfully. This is expected to provide more commercial opportunities for FLNG beyond Malaysia.

Petronas is optimistic about the future of FLNG as there are potentially hundreds of marginal gas fields which would otherwise remain stranded and undeveloped without this technology. Petronas continues to improve its innovation edge through the implementation of its two PFLNG projects – a clear testament to the company's zeal in securing its position on the global energy map, truly a game changer for the LNG industry.

Datuk Abdullah Karim is Vice President for LNG Projects at Petronas (www.petronas.com.my).

▲ As the process of construction nears completion, the complexity of the work involved in the project is evident in this photograph from March this year.

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Responsible operations

- **Amin H. Nasser, Acting President and CEO of Saudi Aramco**, opens the Responsible Operations section with an examination of the importance of running an energy-efficient operation.
- Highlighting the positive role oil and gas companies can play in mitigating climate change, **Brian Sullivan, Executive Director of IPIECA**, explains how operators are part of a sustainable future.
- The Arctic may be the final frontier for hydrocarbon development. **Liv Hovem, Director for Europe and Southern Africa of DNV GL – Oil & Gas**, discusses how this sensitive region's resources can be explored and extracted with safety and the environment as paramount concerns.
- **Ambassador Jeanne L. Phillips, Senior Vice President, Corporate Affairs and International Relations of Hunt Consolidated, Inc. and President of Hunt Global Partnerships**, shares a case study from Peru. It focuses on sustainable development and multiple community projects that the company is working on in partnership with local stakeholders.
- **James D. McFarland, President & CEO of Valeura Energy Inc.**, outlines Turkey's shale gas potential and the plans operators have to increase operations in the coming years.
- Deepwater safety is another important concern for many operators. **Brian Salerno, Director of the US Bureau of Safety and Environmental Enforcement**, writes about the balance between the pace of technical change and maintaining safety standards.
- **Brett Doherty, Chief Health, Safety, Environment and Quality Officer for RasGas** share's best practice health and safety from the Qatari operation.
- **Repsol's Director of Safety and Environment, Jaime Martín Juez** looks at the importance of fostering a corporate culture that prioritises safety and the environment.



Unlocking energy efficiency: A win-win strategy

Saudi Aramco offers a case study in reaping the benefits of a comprehensive energy efficiency programme.

By Amin H. Nasser



Economy, energy and environment are critical and concurrent priorities around the world, so every energy sector must share in the responsibility of delivering energy to the world that is reliable, affordable and environmentally acceptable. That is the inspirational challenge our world faces, and the test that we must pass as an industry.

According to figures from the United Nations, it is estimated that by 2040 the world's population will be almost 9 billion – that's 2 billion more people than today requiring jobs and a decent standard of living. This growth and the expansion of emerging economies will contribute to a 35% increase in overall energy demand, as reported in the ExxonMobil Outlook for Energy: A View to 2040. The OPEC 2014 World Oil Outlook indicates that global oil demand

alone, for example, is expected to rise from around 91 million barrels per day (b/d) currently to 111 million b/d in 2040.

In the decades ahead, Saudi Aramco will continue to play its part by continuing to build reserves and bring new fields on-stream. However, I believe that to fulfil our potential, we also need to pay much greater attention to the most obvious, but often over-looked demand-side solution in our armoury: energy efficiency.

Energy efficiency: a global, invisible powerhouse

Energy efficiency – the “invisible fuel” – is the cheapest and cleanest fuel source that we have available to significantly help meet demand, curb emissions

The fifth largest oilfield in the world

With a production capacity of 900,000 b/d of Arabian Heavy crude oil, 90 million standard cubic feet per day of sour gas and 65,000 b/d of hydrocarbon condensate, Manifa is the fifth largest oilfield in the world and one of the most challenging field developments Saudi Aramco has undertaken.

Manifa incorporates the largest extended reach drilling project in the world and project start-up involved the construction of 27 artificial islands connected by 40 km of causeway.

The project embeds innovative solutions to protect the shallow water environment and marine habitat of Manifa Bay. During the 2014 international Offshore Arabia Conference and Exhibition, the Manifa field was honoured with the 1st Place Environmental Award in recognition of its excellent environmental stewardship.



and reduce cost. Energy efficiency is a “low hanging fruit” that requires us to utilise what is already on tap and in the pipeline.

Saudi Aramco has implemented a wide range of innovative energy efficiency measures to optimise the company's energy supply, save energy across all operations and create opportunities for sustainable growth. Our holistic approach, evolved over decades, combines five principal elements.

1 Integrated strategy: efficiently unlocking the full potential of hydrocarbons

Energy efficiency at Saudi Aramco starts with our integrated strategy. Today, we produce approximately one in every eight barrels of the world's crude oil. Every percentage increase in recovery adds millions of barrels of recoverable oil to our reserves base. Every gain in operating efficiency expands our ability to provide energy at lower cost, benefiting Saudi Arabia and our customers around the globe, and also ensuring that we maintain adequate spare capacity to help stabilise the world oil market whenever disruptions occur.

But as the steward of the Kingdom's vast hydrocarbon resources, we have a responsibility to capture their full economic value. That is why, while maintaining our upstream focus, we have also expanded across the hydrocarbons value chain by taking advantage of our ready-access to cost-effective feedstocks and unrivalled opportunities to integrate with our refineries. This transformation of our business model aims to continuously create value, sustainability and efficiency.

2 Continuous investment in technology and technology partnerships

Second, our integrated strategy is backed by a commitment to continuous investment in technologies that increase recovery rates – such as reservoir management, SmartWater™ flooding, advanced modelling and data-sensing – and drive efficiency across our entire production value chain.

Game-changing technology investments under way include, for example:

- A large-scale demonstration project to use CO₂ in the Uthmaniyah area, located in the Eastern Province, to enhance oil recovery,





potentially boosting recovery rates and sequester carbon dioxide;

- A pilot project using surfactant/polymer formulations in injected water to help recover tertiary oil (oil not produced under natural reservoir pressure or through water injection) more efficiently;
- Investigating a new class of chemicals to reduce the viscosity of heavy oil with the potential to increase recovery compared to water injection.

Our global network of 11 research centres and technology offices, augmented by a wide range of partnerships and venture capital investments, keeps us at the forefront of energy innovation.

3 Energy Management Programme focused on operational excellence

Third, our Energy Management Programme (EMP) looks at opportunities to systematically embed excellence in energy efficiency across all areas of our operations. This programme has four main objectives: reduce the energy key performance indicators of existing Saudi Aramco facilities by 2% per year; design all new Saudi Aramco facilities to be energy efficient; increase overall energy efficiency; and, promote efficiency at the national level.

Within 15 years of launching EMP, our cumulative reduction in energy consumption only within the Company has reached 161,000 barrels of oil equivalent per day; and our energy assessments have identified more than 700 energy savings opportunities.

Last year, as a result of the programme, we continued to experience an improvement in our overall energy performance with energy intensity decreasing by 5.4% compared to 2013. We also achieved a reduction in our total energy consumption by nearly 2% compared to 2013.

One example of the breadth, depth and success of EMP is our 900,000 barrel per day crude oil programme at the Manifa field, where we have deployed a high efficiency combined cycle power generation system – a 420-megawatt system that is self-sufficient in power. It also provides process steam. Building on this, plans for new cogeneration plants

are under way at our Abqaiq, Hawiyah, and Ras Tanura facilities.

4 Reducing environmental footprint and protecting biodiversity

We have reduced our CO₂ footprint six-fold over the last four decades and reducing gas flaring to below 1% of our annual gas production. In 2014, we implemented zero discharge technologies at 432 well sites, a 4% increase compared to 2013. Implementation of the zero discharge technology made possible the recovery of 2.6 billion standard cubic feet of gas and more than 215,000 barrels of crude oil in 2014.

Company-wide, we are implementing a comprehensive water conservation policy, which mandates water conservation road maps for each operating facility. Additionally, we have had a waste recycling programme in place since 1992 to implement environmentally sound disposal methods.

Our environmental activities are not confined to our operational areas. We are also implementing world-leading biodiversity projects to help protect and renew the Kingdom's rich habitats and diverse ecosystems.

5 From Company to Kingdom: supporting a new national framework for energy efficiency

Saudi Arabia's current energy consumption per capita is more than triple the world average. Every day, the Kingdom consumes nearly 1.0 million barrels of oil equivalent of road transportation fuels. In addition, the Kingdom's population is growing strongly. As the population increases, so does the demand for transportation and many other end-uses of energy. The number of vehicles is estimated to reach 20 million by 2030, which would mean a daily consumption of about 1.8 million barrels of oil equivalent.

We are, therefore, proactively championing a number of initiatives that support goals to reduce the Kingdom's energy intensity, including collaborating with major utility sector stakeholders to devise and issue a 10-year, integrated utility expansion plan.

Saudi Aramco is committed to the energy efficiency drive pioneered by the Saudi Energy Efficiency

The world's biggest car park shade

Saudi Aramco's Al-Midra office building in Dhahran uses solar panels that double as sunshades over its 4,500 parking spaces. Covering an area of 198,350 square metres

and using over 126,000 solar panels, it stands as the world's biggest car park shade and generates 10 megawatts of energy for the Al-Midra Complex.



Program, a subcommittee of the Saudi Energy Efficiency Center (SEEC), which has been tasked with the establishment of a comprehensive national program to rationalize energy consumption.

We are supporting a campaign through 2016 to improve fuel economy in new and used cars that requires the adoption of a new set of energy efficiency standards, and we are working with the automotive industry to investigate ground-breaking advancements in integrated engine-fuel systems to dramatically improve mileage efficiency and reduce emissions.

The challenge ahead to 2040

Having briefly highlighted some of Saudi Aramco's actions in energy efficiency and I know that many in our industry are also making great strides, collectively, there is still much more to do.

Our industry is more powerful and impactful when we work together. That is why I am proud that Saudi Aramco joined with other major oil and gas companies that account for a significant share of global oil and gas production – including BG, BP, Eni, PEMEX, Sinopec, Shell and TOTAL – to launch the Oil and Gas Climate Initiative (OGCI), a voluntary, industry-driven initiative to tackle climate change where energy efficiency is an important element.

Given the scale of the global climate change challenge, we must not be daunted. I believe that, through partnership and collaboration, our industry can continue to transform its energy efficiency, paving the way to a better tomorrow.

Amin H. Nasser is acting President and CEO of Saudi Aramco (www.saudiaramco.com).

Leading the industry on climate change

The oil and gas industry – a positive part of a sustainable energy future.

By Brian Sullivan



IPIECA is the global oil and gas industry association for environmental and social issues. It was formed in 1974 following the launch of the United Nations Environment Programme (UNEP). IPIECA is the only global association involving both the upstream and downstream oil and gas industry on environmental and social issues.

Through member-led working groups, IPIECA brings together the collective expertise of oil and gas companies and associations. These groups draw on the skills and experience of our international membership and operate with support from a secretariat. IPIECA currently has working groups that address the following areas: biodiversity, climate change, health, oil spill preparedness, fuels and products, reporting, social responsibility, and water.

The challenge

Today, oil and natural gas provide over 50% of the global primary energy essential for the world's economies and human development. However, while powering over 200 years of industrialisation

and economic development, the use of fossil fuels – coal, oil and gas – has contributed substantially to the rise in atmospheric carbon dioxide (CO₂) from an estimated level of 275 ppm in 1750 to around 400 ppm today.

Yet, with energy demand anticipated to grow almost 40% by 2040, oil and gas will continue to be vital to meet growing demand in the developing world. Gas provides a low-carbon alternative to coal for power generation and can complement the variability of renewable energy sources as a flexible base load. Oil continues to be the world's primary transport fuel, with few viable alternatives today. Continued human and economic development, especially in emerging economies, is dependent on affordable, reliable, sustainable and modern energy.

The members of IPIECA believe it is possible to address climate change risks while also meeting growing global energy demand and supporting economic development. As an industry, we are already taking a range of actions across our own operations and products to support these goals.

► Reducing gas flaring is one way the industry is working towards climate change targets.



Here, I present how IPIECA and its members are participating in the challenge of reducing emissions, developing and implementing new technology, and grasping opportunities to provide new and suitable energy options.

IPIECA's response

Historically, IPIECA has been a catalyst in bringing the industry together to focus on climate change issues to facilitate broader understanding and enable performance improvements. Our good practices cover areas including energy efficiency, flaring reductions and raising the standards and transparency of reporting.

As climate change and GHG emission mitigation continues to rise up the agenda, IPIECA strives for ongoing transparency and dialogue with stakeholders on this crucial topic. 2014 witnessed a continued discussion on the concepts of unburnable carbon, stranded assets and a carbon bubble, which have gained much attention from investors, academics and the media. To address some of the assumptions inherent in these concepts and to place the concepts in the wider perspective of the energy system, IPIECA published a factsheet titled *Exploring the concept of "Unburnable Carbon"* in June 2014. This was followed by a side event at the 20th Session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) COP-20, held in December 2014 in Lima, Peru. The event provided further discussion on unburnable carbon in the context of the future energy system, and the role of mitigation technologies such as Carbon Capture and Storage (CCS).

Efforts to mitigate the risks of climate change have primarily focused on reducing emissions of CO₂, yet recent work has broadened this focus to consider other forcing agents, such as short-lived climate forcers (SLFCs). While real opportunities exist with the inclusion of SLFCs in climate change mitigation, uncertainties remain surrounding their sources, climate effects and strategies to manage their emissions. To keep members abreast of developments, in July 2014, IPIECA published a report entitled *Understanding short-lived climate forcers*,



which explored some of the major themes impacting the SLFCs discussion.

IPIECA leads industry engagement with the UNFCCC as well as the Intergovernmental Panel on Climate Change (IPCC). The release of the IPCC's 5th Assessment Report in 2014 was a critical addition to the climate science discourse. To further explore these topics, IPIECA organised a business and industry engagement workshop in September 2014, which included speakers and panellists from the IPCC and across the expert business community.

2014 also saw IPIECA further its work on energy efficiency and GHG mitigation through a series of webinars. Webinars entitled *Guidelines for implementing ISO 50001*, *Preparing effective flare management plans* and *IPIECA-IOGP's Energy and greenhouse gas efficiency compendium* were led by industry experts and aimed to further disseminate IPIECA's work and ensure it remains evergreen.

A focus on COP 21

From 30 November to 11 December this year, COP 21 will be convening in Paris. The upcoming conference will bring together national governments with the aim of agreeing international action on climate change to keep global warming below 2°C above pre-industrial levels.

▲ IPIECA has been actively involved in the UNFCCC process from the Rio Earth Summit in 1992 to COP 20 in Lima.



▲ Looking towards COP 21 in Paris later in the year, the transition to zero net emissions is a task that all sectors of society must work towards.

Adopted during the 1992 Rio de Janeiro Earth Summit, ratified by 196 countries, and in force since 1994, the UNFCCC acknowledges the reality of anthropogenic – or human-induced – climate change. In the run-up to COP 21, negotiations and discussions between governments and a wide range of stakeholders are already underway, and the expectation is that Paris will see a landmark agreement to tackle a global challenge with global action. These UNFCCC negotiations have the potential to instigate a step-change, both for governments and for the private sector, in the global effort to reduce GHG emissions and manage the risks of climate change.

Over the past two decades, IPIECA has actively participated in the UN climate negotiations from Rio through to Lima. In the run up to COP 21, we renew our efforts to engage with stakeholders in the UNFCCC process and believe the oil and gas industry's history, global reach, knowledge and technical expertise enables us to help develop and provide credible future energy solutions. Our aim is to highlight the fundamental contribution the industry can play in transitioning the energy system to a low-emissions future.

IPIECA supports and encourages governments in their efforts to reach an effective and clear international agreement to reduce GHG emissions and to manage the risks of climate change.

The Paris Puzzle

The IPCC 5th Assessment Report identified a direct correlation between the cumulative release of carbon into the atmosphere and eventual peak warming. The report noted that the cumulative release of one trillion tonnes of carbon (or 3.7 trillion tonnes of CO₂) will very likely result in the warming of the climate system by 2°C above pre-industrial levels, with more than half of this stock already emitted. Current projections show that one trillion tonnes of carbon could be released as early as 2039. Addressing the issue of climate system warming will mean limiting the cumulative emissions of carbon dioxide over time.

IPIECA recognises this is an enormous challenge in terms of scale, cost and complexity. Current global CO₂ emissions from all anthropogenic sources stand at some 40 billion tonnes per annum and are associated with almost every aspect of human life, society and endeavour. The transition of the energy system is the challenge of our generation and the next, requiring significant policy action, technology development and business and civil society response.

IPIECA has developed a series of factsheets entitled *The Paris Puzzle*, which lay out the challenges the world faces in attempting this transition, and also identify in detail the critical parts of the puzzle as we see them: access to energy, CCS, managing our emissions, natural gas and policy frameworks. There is more information on IPIECA's work on climate change and *The Paris Puzzle* on the website, www.ipieca.org.

Much more needs to be done to address climate change. With the right policy frameworks and incentives to encourage investment in transforming technology, all the stakeholders can cooperate to achieve effective solutions. For our part, we will continue to underscore the importance of partnerships between all sectors and stakeholders to build on existing performance and expertise, improve understanding and ultimately progress on this complex issue.

Brian Sullivan is the Executive Director of IPIECA (www.ipieca.org).



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Taking the chill out of Arctic operations

Ambitions for Arctic oil and gas development remain strong but access, safety and the environment are paramount concerns.

By Liv Hovem



With the oil price spiralling towards a six-year low, some industry leaders argue that the commercial appetite for oil and gas activity in the Arctic is cooling of late. Taking into account the varied nature of the environment, the sensitivities surrounding infrastructure development, climate change and the unique Arctic ecosystem, further development is – understandably – being carefully scrutinised, while recognising the benefits from increased Arctic development.

It is the world's increasing demand for energy that keeps ambitions alive to make a play for the frozen spoils. The assessment of Arctic mineral resources from the US Geological Survey (USGS), states that the region may contain 13% of the world's undiscovered oil (mostly from unexplored regions), and 30% of its undiscovered gas.

Mapping risk

The Arctic is highly diverse in terms of its seasonal conditions as well as its local environments and political landscapes. Consequently, so are the complex risk factors it presents. There are visibly inc-

reased activities related to industry, population changes and transport in the exposed Arctic waters. Oil and gas infrastructure is, for example, ample in northern Norway, but minimal on the Alaskan Chukchi coast.. Large parts of the south Barents Sea have operating conditions similar to the fields found in the Norwegian Sea in terms of wind and waves, and with no sea ice.

The common factor across the ice cap is the severe Arctic conditions for several months of the year. However, operating under such extremes does not have to be a high risk activity. By combining effective risk management with research, continuous learning, cooperation and new technologies, a business can reduce the risk of its operations to an acceptable level.

To develop a better understanding of the potential gains and technical and environmental hurdles of future activity in the region, DNV GL has developed an Arctic Risk Map. The map is a valuable, publicly available tool, to help Arctic stakeholders to visualise and increase understanding of the complex information needed to make decisions around Arctic development. It can assist industry leaders when it comes to planning activities and imposing risk reducing measures throughout the year.

Large variations in climate, species distribution and human activity influence the environmental risk picture in the Arctic. Analysis shows that the region is at its most vulnerable during summer, when industrial activity collides with important life stages for the Arctic's inhabitants.

Technical measures should always be guided by clear operating principles. With good management, all petroleum and maritime operations should attain a reasonable level of safety. However, determining whether a risky operation should proceed is

▼ Efforts to minimise the effects of oil and gas exploration on Arctic species such as the polar bear add an extra layer to the decision-making process.



often a values-based judgement. Decision-makers, such as authorities or members of the public, must determine whether the benefits justify the risk – in the case of drilling in Norway's Lofoten islands, it was decided that they didn't, whereas the risk was considered worth taking with the decision to open up the Barents Sea's 23rd licence.

The Polar Code

The International Maritime Organisation (IMO) recently adopted the International Code for Ships Operating in Polar Waters (Polar Code) and related amendments to the International Convention for the Safety of Life at Sea (SOLAS). The goal is to further reduce risks to the environment and ecosystems of the polar region, as well as upholding the safety of those working in such volatile conditions. The move marks a historic milestone in the organisation's work to protect ships and their passengers in polar conditions.

Trends and forecasts indicate that polar shipping will grow in volume and diversify in nature over the coming years – the intention is for the Polar Code to ensure the safety of life at sea and the sustainability of the environment while not being so stringent that it hinders the societies in the North.

Ships operating in frozen conditions may encounter a variety of hazards, including the icing of systems and equipment, liquids in tanks and pipes freezing, large loads and impacts from heavy ice conditions and drifting icebergs and growlers (small, barely visible icebergs). Correctly identifying prevailing ice conditions will help protect a vessel from significant ice damage. Appropriate dimensioning methods are also needed to ensure the vessel has the necessary structural integrity.

Winterisation

Winterisation is the process in which ships are prepared for extreme icing, freezing weather systems and wind chill. Sea spray icing is one of the many challenges when operating in Arctic conditions. It poses a threat on multiple levels, from blocking the operation of essential components to jeopardising



stability and integrity and in extreme circumstances, such as a capsized vessel, a heightened risk to life.

A number of standards, for example DNV GL's offshore standard "Winterisation for Cold Climate Operations (DNV-OS-A201)", provide guidance on mitigating ice accumulation using specified anti- and de-icing procedures. A potential shortcoming with today's rules is that they may be too strict in some places while being too lax in others. Unfortunately, the industry lacks adequate experience to make these judgements and until further knowledge is gained, it is difficult for the rules to be revised.

The "RigSpray" joint industry project (JIP), initiated by DNV GL, aims to provide a methodology which would link requirements for structural design and the environmental conditions that lead to icing. The methodology is to be used during the design phase to provide the basis for selecting adequate measures when icing risk is expected. The "RigSpray" JIP will firstly develop a software tool to further

▲ Many nations are able to claim part of the Arctic's potentially huge hydrocarbon reserves.



▲ While drilling in the Lofoten islands has been decided against, the area remains important for the study of the interface between marine and continental environments in the Arctic.

▼ The significance and inherent dangers of sea spray icing is evident in this photograph. The process of winterisation can help to mitigate this and other cold weather effects on shipping.



understand sea spray icing using mathematical modelling and measurements and will undertake more experimental and modelling studies. This will provide a solid basis for extending local ice estimations to a wider spectrum of meteorological, oceanographic and structural conditions, which in turn will lead to safer and more cost-efficient winterisation solutions for drilling rigs, production platforms and vessels operating in cold climate areas.

In the "MarIce" JIP last year, DNV GL worked with the Norwegian University of Science and Technology (NTNU) and Statoil to create the world's most advanced marine-icing model. Despite making headway in addressing the challenge, further innovation is required to present an accurate representation of sea spray.

Currently, Norway is updating the icing loads in its offshore standard NORSOK N-003, and the

International Organization for Standardization (ISO) is developing a new standard on the collection and analysis of data for design and planning of operations in the Arctic. One of the goals for these activities is to make regulations and standards more specific, and to provide more information to be used during design and operation of Arctic vessels and offshore installations.

Building Arctic infrastructure

Under global ocean law, the Arctic coastal states of the US, Canada, Norway, Greenland and Russia are relatively free to regulate activities on their continental shelves. For example, the Alaska Arctic Policy Commission, tasked with guiding Alaska's lawmakers on the needs and future of the US Arctic territory, announced recommendations in February to enhance Arctic communities through the development of an Arctic port, revenue sharing, oil and gas exploration, spill prevention resources and increased research.

In Russia, where oil and gas production is decreasing, the government has launched a fervent economic exploration programme. In December 2014, the discovery of the new Arctic oil and gas field Pobeda (Victory) was confirmed. This is located in the Kara Sea.

Up to 2030, Russia plans to spend \$400 billion on hydrocarbons exploration in the Kara Sea. Russian leaders have also announced plans to expand the country's polar borders by 1.2 million km² through the United Nations. This would place the country in a prime position to take advantage of natural gas and oil reserves while positioning itself to take part in future trade through the frozen ice plains. However, with sanctions targeting Russian interests, the possibilities for technical specialists to support Russia's Arctic ambitions are limited.

In Norway, global warming has seen the ice retreat further north, fuelling debate on where the edge of the marginal ice zone is now located. In February 2015, the Norwegian oil ministry offered companies 61 blocks, nearly all in the Barents Sea and some in the most northern waters ever opened

for exploration. Then in April 2015, the Norwegian government released a revised management plan for the Barents Sea including a controversial updated contour of the edge of the marginal ice zone situated north of all the offered blocks. Oil companies faced with declining North Sea oil and gas reserves have pushed for new prospecting licenses in areas that were previously off-limits.

Regardless of political willpower across the polar ice cap, strong regional and commercial cooperation is essential to tackle the complexity, risks and high costs of Arctic development. The potentially enormous hydrocarbon reserves that lie within the Arctic are obviously attractive to countries with territorial claims to the area, as well as global energy giants with the means to exploit them. To reduce the risks inherent in extraction, all players must adopt a common risk-management strategy.

Knowledge sharing

The risks maritime and petroleum operators face in the Arctic are as diverse and dynamic as the ice sheets that sculpt the face of this unique region. In addition to wide variations in geography and seasonality, operators must deal with extreme conditions and a lack of infrastructure. Though the risks associated with oil and gas exploration have been well documented, experience has also revealed gaps in expertise.

Much of the current practical knowledge is localised and limited to a relatively small number of specialists. Companies with an interest in the region have an obligation to educate employees of the operational and practical realities involved in any Arctic activity and share this information. DNV GL and Statoil have worked together to prepare employees for operational realities in the Arctic through the Arctic Competence Escalator (ACE) programme.

A stepwise approach

DNV GL believes a “stepwise” approach to developments in the Arctic is needed. This means operators must master the least challenging regions of the Arctic before contemplating developments in



the high-risk areas. However, each step of such an approach must be considered carefully to ensure that the risk level is acceptable. With the very low frequency of events that we can allow for, successful operations for a period cannot be considered as evidence in itself that the risk level is sufficiently robust to take on more challenging conditions.

Transparency in understanding and management of risks will also be essential to earn the social licence to operate and minimise the impact of activities.

Risk-based approach

Despite the recent announcement that Shell is determined to restart Arctic drilling this summer, wide-scale offshore oil and gas development in the Arctic appears to be “on ice” for now. However, with such high stakes, the Arctic will be a defining frontier – not just for operations, but for safer, smarter, greener technologies and standards. The region is rich with resources and dilemmas and, while there are no easy answers to these quandaries, the oil and gas industry must tackle questions and source solutions based on a common understanding of the risks.

By combining effective risk management with research, continuous learning, cooperation and new technologies, a business can reduce the risk of its Arctic operations to an acceptable level.

Liv Hovem is the Director for Europe and Southern Africa of DNV GL – Oil & Gas (www.dnvgl.com).

▲ Developing the oil reserves around Sakhalin Island in the Russian North Pacific has strengthened knowledge for operating in the Arctic.

A case study for sustainable development in Peru

The Hunt Global Partnerships programme has worked on multiple projects in conjunction with its Peruvian operations.

By Ambassador
Jeanne L. Phillips



▼ The Hunt Global Partnerships programme "Promoting Healthy Communities" has created notable improvements in the prospects for young people in its area of operation.

In the field of community relations and corporate social responsibility, it is important to consistently remind ourselves that amidst efforts in the industry to gain a "social licence to operate" with various sets of stakeholders, ultimately we are working with human beings, often in dire living conditions. Ever at the centre of truly responsible corporate engagement programmes are the people and the families in the communities touched by our activities.

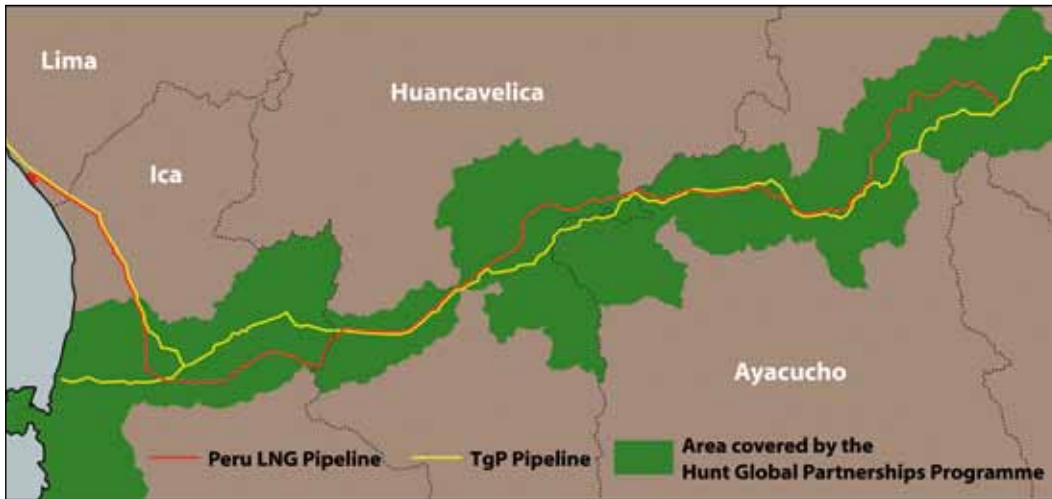
At Hunt's core, we understand people and families, and the values that underpin our organization – commitment to excellence, honesty, integrity, respect for the individual, teamwork and creativity – stem from our family-owned structure and corporate culture. We are a privately held exploration and production company that has successfully conducted petroleum operations for more than 80 years. Today, Hunt is one of the leading indepen-

dent energy companies in the United States, with operations in North America, South America, Europe, Australia and the Middle East. We have drilled wells on every continent except Antarctica.

Everywhere we go around the globe, we absorb new members into our Hunt family. We engage these people as partners, in a model that addresses critical needs in the lives of real people. In the end, it is not only our obligation but our unique opportunity to improve their quality of life in a 21st century society that has been developed jointly and sustainably.

Hunt is committed to promoting positive long-term contributions to the economic and social fabric of the countries in which it operates. Hunt Global Partnerships (HGP), created in 2007, is the social responsibility model for the Hunt family of companies. At its foundation, HGP strives to bring to-





◀ Communities along the route of Peru's main gas pipelines served as the ideal beta site for implementing Hunt's new social model.

gether local communities, government entities and non-governmental organisations (NGOs) to provide critical services needed for individuals and their families living in Hunt's projects' area of influence.

Hunt's model focuses on collaboration with strategic partners in the field, coupled with a solid foundation of independent monitoring and evaluation. HGP programmes are implemented by NGOs that have extensive experience in development programmes and that implement best practices in social investment. Each programme begins with a comprehensive, third-party baseline study that is used as the starting point to measure results with the monitoring and evaluation team. We recognise that performance matters; therefore, we review these results annually to ensure that project goals are being met and that programmes are on schedule and within budget.

Hunt Global Partnerships was founded on a set of principles that guides our programme design around the world. They include:

Rigour

- Addressing high-priority problems affecting the target population.
- Focusing on the poorest sectors of the population in the area of intervention.
- Studying local needs with the help of outside experts and in consultation with the communities themselves.

Partnership

- Selecting NGO partners that have a proven record of success through a competitive bidding process.
- Promoting efficiency in the implementation of projects, high-quality services, optimal use of resources and replication of best practices.
- Co-financing by the community through manpower and local materials.

Sustainability

- Respecting the environment.
- Fostering ownership of projects.
- Implementing sustainable projects for the continuity of positive impacts once intervention is complete.

Adaptability

- Adjusting every programme to the particular needs and desires of each community.
- Respecting cultural diversity.

Accountability

- Establishing a third-party baseline study and monitoring and evaluation system to collect important indicators and data.
- Reviewing NGO partners' performance annually before contract renewal.
- Setting clear, measurable goals that are evaluated by an independent panel of expert advisers annually.

**Transparency**

- Providing transparency during project implementation and management of funds.
- Conducting effective communications.
- Publishing our plans, methods and results for the benefit of others contemplating similar work.

As we prepared to enter remote and little-studied regions of Peru, we turned to some of the best and the brightest in the academic world for independent consultation on the ecology and social fabric of the communities with which we were going to engage.

The Hunt Oil Company Peru Advisory Board was formed in 2006, and it comprises three internationally renowned experts in social development programmes, economics and biodiversity. The board advises Hunt on the best approaches for mitigating the social and environmental impacts of the company's operations in Peru.

Currently serving on the Advisory Board are: Wade Davis, professor of anthropology, University of British Columbia, former explorer-in-residence, National Geographic Society; Malcolm Gillis, former president and current professor of economics, Rice University; and Thomas Lovejoy, biodiversity chair, The H. John Heinz III Center for Science, Economics, and the Environment.

A partner in Peru's development

Hunt has been working in Peru for more than a decade and is committed to creating opportunities that have a lasting, positive impact on the welfare of the Peruvian people. In Peru, we identified needs in the areas of basic health and hygiene, education and capacity building, and we tailored our programmes to meet those needs. We provided outreach to more than 50,000 people in the area of influence at the local level, and worked closely with local residents to foster ownership and sustainability for each project. Third-party monitoring reports, which ensure transparency and effective outcomes, were a critical component of the success of the HGP model. Over the last seven years, HGP has established positive relationships with NGOs in Peru

and internationally, and our work has been recognised by the World Bank, the Inter-American Development Bank, the Peruvian government and the World Petroleum Council.

Geographically, Hunt Global Partnerships programmes in Peru have been implemented in the departments of Ayacucho and Huancavelica and the province of Pisco. Parts of Ayacucho and Huancavelica are more than 4,800m above sea level and are among the poorest regions in Peru; when HGP implementation started in 2008, they had poverty rates of 70%. Pisco is in an arid, desert region along the Pacific coast and had a poverty rate of 26% in 2007. Additionally, in August 2007, Pisco was one of the provinces most severely affected by a devastating 8.0 magnitude earthquake.

The "Promoting Healthy Communities" programme

The most widespread health problems in Ayacucho, Huancavelica and Pisco are child malnutrition, maternal and infant mortality, acute respiratory infections and acute diarrheic diseases among children under the age of five. HGP worked with two local NGOs to address these issues by promoting behavioural changes in families to improve household sanitation conditions.

The programme featured workshops covering hand-washing, malnutrition prevention, prenatal care and nutrition during pregnancy, as well as demonstrative sessions on how to prepare high protein meals. Additionally, the health programme constructed more than 2,300 new water systems, latrines and improved kitchens. By the end of its three-year period, "Promoting Healthy Communities" had achieved notably successful results in the region, with average decreases of 43% in the prevalence of chronic malnutrition and 31% in the prevalence of chronic anaemia in children under the age of five.

The "Successful Schools" programme

HGP's education programme focused on four critical areas: quality of teaching, family participation,

school management and support networks. The goal was to improve students' academic achievement by 20% in Pisco (15% in the highlands) in the areas of reading, communication and mathematics over a three-year period. The programme engaged parents to create appropriate home study environments for their children, and it trained teachers and principals on new methods of instruction and best practices in school management.

"Successful Schools" was implemented in partnership with two local NGOs and exceeded the original goals of the programme. Average proficiency in reading increased by 68%, while average proficiency in mathematics and communication increased by 108% and 27%, respectively. In addition, 13,000 school children received backpacks and school supply kits.

The "Developing Local Potential" programme

This government capacity building programme took place in two stages over three years. The first stage focused on management skills, public investment and participatory budgeting, while the second stage of the programme involved the development of quality public investment projects.

Programme participants were able to mobilise funding for 60 projects valued at \$36.6 million from public investment resources in the agriculture, education, health, sanitation and transportation sectors. Thirteen of these projects, valued at a collective \$11.2 million, received financing with HGP support by the end of the capacity building project.

Looking to the future

Through a combination of ongoing community participation, strategic partnerships and independent monitoring and evaluation, we have been able to achieve real, sustainable results over the first seven years of HGP programme implementation. We have learned lessons along the way and have refined our programmes accordingly, but we have carefully abided by our six principles and can now report that the positive results of our model have



been significant. The statistics are conclusive and the personal stories from the communities we have engaged express the local empowerment and shared value that has been developed through Hunt's programmes for the people in the region – a Peruvian family that now includes more than 125 communities and over 50,000 people.

Moving forward, Hunt Global Partnerships will continue to grow its award-winning programmes – and its family – around the world in pursuit of a healthier, smarter, more sustainable future.

Ambassador Jeanne L. Phillips is Senior Vice President, Corporate Affairs and International Relations, Hunt Consolidated, Inc. and President, Hunt Global Partnerships (www.huntconsolidated.com).

▲ Health workers implementing Hunt Global Partnerships initiatives have been recognised by Peru's Ministry of Health for their positive contributions.

Awards and recognition for HGP

2009 Best Corporate Social Responsibility Campaign, Petroleum Economist magazine.

2010 Sustainable Development Award for Promoting Local Development, Peru's National Society of Mining, Petroleum and Energy.

2012 Sustainable Development Award for Promoting Local Development, Peru's National Society of Mining, Petroleum and Energy.

2014 World Petroleum Council's Excellence Award in Social Responsibility at the 21st World Petroleum Congress in Moscow.



A Turkish perspective on unconventional gas

Unlocking Turkey's unconventional gas potential will be a game-changer for the country's economy and regional energy security.

By James D. McFarland



The revolution in technology that has enabled the recovery of oil and gas from unconventional source – such as tight oil and gas, shale oil and gas, oil sands and oil shale – has made an enormous contribution to hydrocarbon production in North America. Many other parts of the world are similarly endowed with unconventional resources that can rival those in North America but the pace of development has been very slow. However, some jurisdictions have recognised the opportunity and have put in place policies aimed at accelerating activity and unlocking their nation's unconventional hydrocarbon potential.

Turkey is a case in point. The national oil company, Turkish Petroleum, in partnership with Shell, is active in the Anatolian Basin in southeast Turkey where it is pursuing shale oil and gas with horizontal drilling and multi-stage hydraulic fracturing technologies. Smaller North American based independent oil and gas companies such as TransAtlantic Petroleum Ltd. (TransAtlantic), Valeura Energy Inc. (Valeura) and Pinnacle Turkey Inc. (Pinnacle) are developing tight gas in the Thrace Basin in northwest Turkey with similar leading edge technologies. These initiatives hold great promise for the country.

Turkey is a very small oil and gas producer, satisfying less than 5% of its hydrocarbon demand from indigenous sources. The country has a large and growing population of more than 80 million people with a growing energy appetite that is served primarily by oil and gas imports and indigenous coal production.

Despite current low production levels, Turkey has a number of proven petroleum systems that many experts consider to be under-explored and under-exploited, particularly from the standpoint of un-

conventional resources. As one measure of that potential, the US Energy Information Administration (EIA) in their 2013 assessment estimated that total recoverable resources from shale in Turkey could exceed 644 billion cubic metres of gas and 4.7 billion barrels of oil. These estimates exclude other unconventional tight oil and tight gas resources. Typically, exploitation of these unconventional resources requires application of more sophisticated and expensive technologies such as 3D seismic, hydraulic fracturing and horizontal drilling, and sufficient field activity to build learning curves and define the keys to unlock the potential.

Investing the significant capital required will only be made in a business environment that rewards risk takers, and Turkey has done a commendable job in building the foundation for such an environment. Given its location, Turkey is a natural energy hub with multiple pipelines traversing the country and has developed a very sophisticated view of the energy business. The country has one of the more attractive fiscal and royalty regimes, with a flat 12.5% royalty rate and a 20% corporate tax rate.

Turkey has a well-established petroleum law from 1954 which was refreshed in 2013. The law is administered by the General Directorate of Petroleum Affairs (GDPA). The oil and gas industry in Turkey is served by domestic and global service companies, which has kept costs competitive and comparable to North America. Given the high level of energy imports, there are ready domestic markets for indigenous production that can mitigate imports and improve supply security for the country. Producers are also able to capture oil prices linked to Brent and domestic natural gas prices in excess of \$9/per thousand cubic feet.

Natural gas development in the Thrace Basin

The Thrace Basin in northwest Turkey is the country's main natural gas-producing region. The basin has seen a significant increase in activity since 2011, focused on exploiting unconventional tight gas resources which underlie the more mature conventional shallow gas formations. This activity has largely been driven by the Thrace Basin Natural Gas Joint Venture (TBNG JV) owned by TransAtlantic (41.5%), Valeura (40%) and Pinnacle (18.5%). More than \$300 million has been invested in the past four years to acquire land and other assets, shoot 3D seismic, drill vertical and horizontal wells and fracture more than 70 wells to prove up the tight gas potential.

The Thrace Basin is a well-known, large Tertiary-age sedimentary basin that underlies most of the European side of Turkey. More than 11.2 billion cubic metres of natural gas has been produced from the basin with current production of about 1.82 million cubic metres per day. There is an extensive natural gas infrastructure in the area, including the Russian West pipeline system, which runs through the basin to the Istanbul area.

There are a number of play types in the Thrace Basin as shown in *Figure 1*. These include the conventional shallow gas play on the flanks of the basin as well as the tight gas play in deeper formations where porosity and permeability decreases

with depth. There is also potential for a basin-centred gas accumulation in the deepest part of the basin below about 3,000m. Basin-centred gas accumulations such as those well-developed in North America are characterised by over-pressured more pervasive gas accumulations.

TBNG JV Tight Gas and Shallow Gas Programme

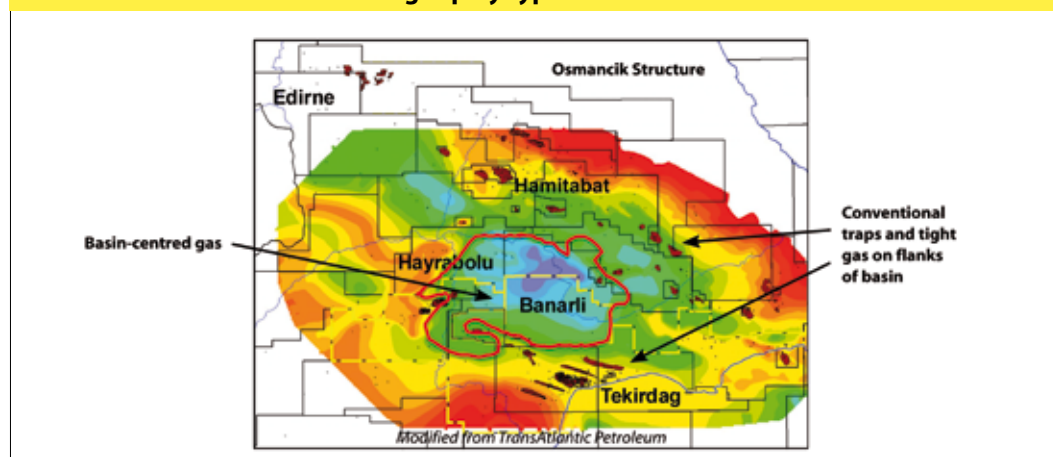
Shallow gas on the TBNG JV lands is produced from high porosity sands in the Danisman and Osmancik formations down to a depth of approximately 1,000m as shown in *Figure 2*. Selective drilling on new 3D seismic and workovers continue to be pursued to optimise this part of the business.

However, the emphasis in the past four years has shifted to the deeper, tight gas sands below 1,000m, which potentially have thicker net pay and higher reserves per well. These sands are found in very thick sand-shale sequences in the Mezardere, Teslimkoy and Kesan formations and generally need to be fractured to achieve commercial producing rates.

It is notable that there are no restrictions on hydraulic fracturing in Turkey.

Since July 2011, the TBNG JV has carried out an extensive tight gas proof-of-concept programme to de-risk the play. The initial phase focused on re-entering selected existing deeper wells to fracture stimulate certain tight gas intervals of which 55 such re-entry fractures have been completed to

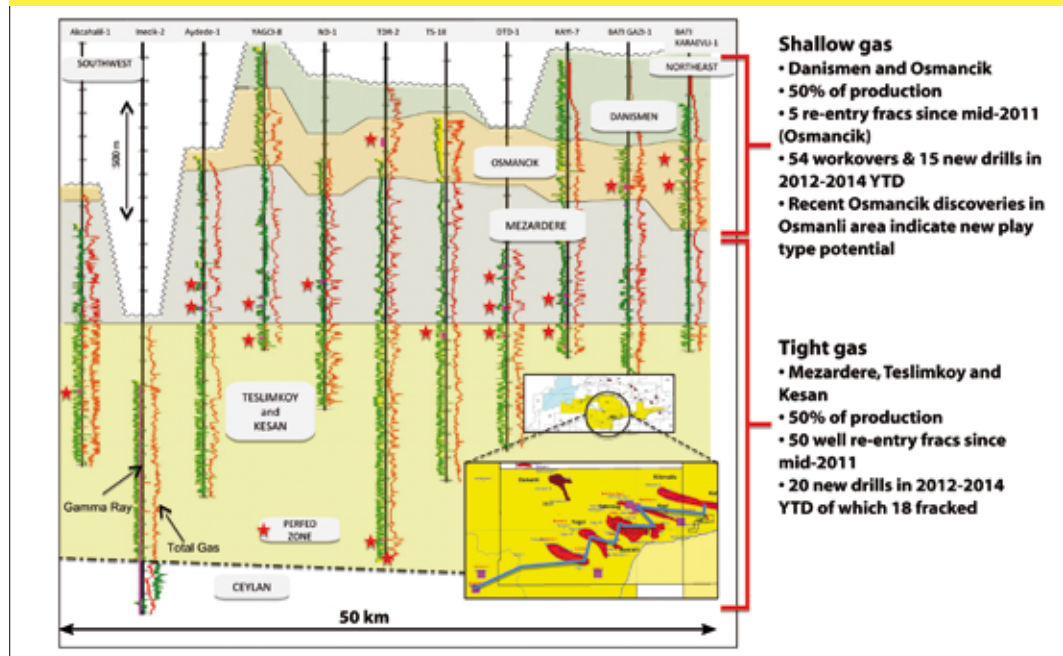
Southern Thrace Basin natural gas play types



◀ Figure 1.



TBNG Tight Gas & Shallow Gas Programme 2011-2014



► Figure 2.

date. In 2012, a second phase was initiated involving drilling deeper wells on new 3D seismic. Some 650km² of new 3D seismic has been acquired to date. Twenty new wells have been drilled down to depths of 4,050m, all indicated gas wells, and 18 of these have been fractured. Six of these 20 new wells are horizontal wells that have been fractured with up to 10-stage fractures. Extensive core analysis work has also been carried out. Based on this extensive program, the TBNG JV expects a typical hydraulic fracturing development well will yield recoverable

reserves of about 22.4-39.2 million cubic metres per well.

Tight gas horizontal drilling

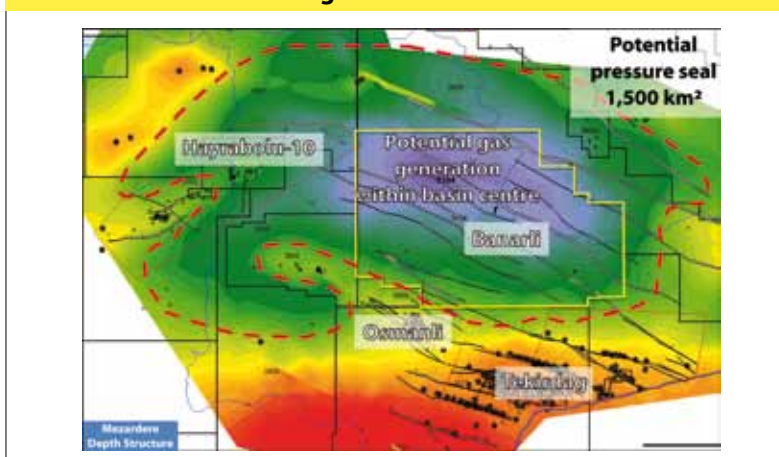
The tight gas proof-of-concept programme involved drilling six horizontal wells, which were completed with multi-stage fractures.

The first horizontal well DTD-19H was a learning experience and had a relatively modest lateral of 425m into the Upper Kesan formation at a vertical depth of about 1,100m. It took 35 days to drill and complete with a seven-stage fracture. The average initial rate over a 30-day period ("IP30") was about 11,200 cubic metres per day, a rather disappointing result. Contrast this initial result with later wells which were drilled in as little as 11 days with longer laterals of up to 680m completed with up to 10-stage fractures and achieving IP30 rates up to 84,000 cubic metres per day.

Costs to drill, complete, fracture and tie-in these horizontal wells have been reduced from \$3.5 million for the first well to \$2.1 million for the last well, primarily through reductions in drilling time. Ultimately, the tight gas resource on the TBNG JV lands will likely be developed with a mix of vertical and horizontal wells.

▼ Figure 3.

Potential basin-centred gas accumulation



Potential unconventional tight gas basin-centred play

In addition to the conventional shallow gas and unconventional tight gas potential in the Thrace Basin, there is also potential for a basin-centred tight gas play in the deeper part of the Thrace basin. Valeura has interpreted an area of more than 1,500km² within the dashed red line shown in *Figure 3*, which may be over-pressured below a depth of about 3,000m. At this depth and associated temperature, there may be an active “kitchen” present where gas continues to be generated from kerogen-rich source rocks in the Mezardere formation. Data from five deep wells drilled in the general area indicates this over-pressure phenomenon.

This interpreted over-pressure area encompasses Valeura’s 100% owned Banarli Licence and parts of the TBNG JV lands. Valeura and the TBNG JV partners would like to see the concept tested in 2015, but will likely require larger partners to share the costs and risk to drill and fracture several exploration wells to depths of 4,000 to 5,000m.

Economics

The economics of unconventional natural gas production in the Thrace Basin are very attractive when given access to world prices, a competitive fiscal and royalty regime and relatively low operating and capital costs. One indicator of this is the operating netback which can be measured as revenue less royalties and field operating costs. In the case of the TBNG JV, these operating netbacks in the first nine months of 2014 averaged in excess of US\$36 per boe.

Wellhead price realisations (Cdn\$), shown at the top of the bars, have grown significantly over the past three years as the government owned entity Boru Hatlari ile Petrol Tasima Anonim Sirketi (BOTAŞ), which owns the main pipeline systems in Turkey and imports almost all the gas to the country, has raised its reference price to reduce its buy-sell deficit.

All of the TBNG JV gas sales contracts with 55 light industrial users are linked to a negotiated percentage of the BOTAŞ reference price. The 6% decline in realised prices in the first nine months of

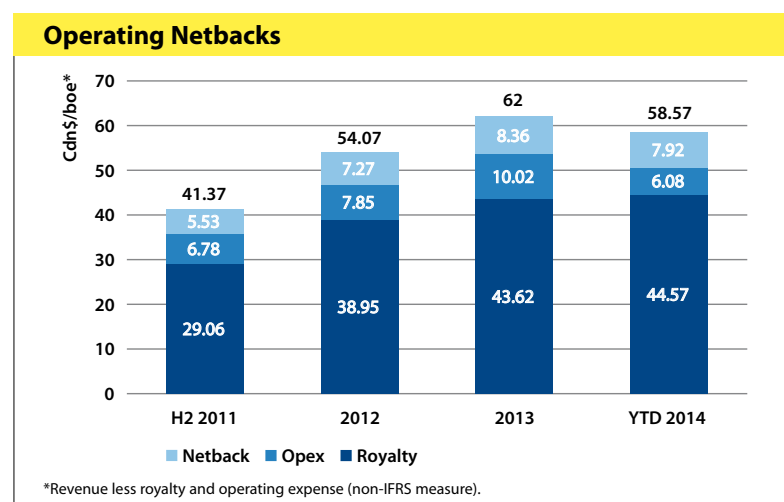
2014 compared to 2013 is due to the weakening Turkish Lira, the pricing basis of domestic gas sales. BOTAŞ raised its reference price by 9% effective October 1, 2014 which has pushed up current well-head price realisations to similar levels as those enjoyed in 2013. Unit operating costs have declined significantly from 2013, reflecting a decrease in top-line costs and growth in volumes.

Target costs for well re-entry fractures and new drill and fracturing programmes are expected to be achievable with further efficiency improvements. In terms of individual well economics at these target costs for tight gas horizontal and vertical wells with multi-stage fracture completions recovering an average of 28 million cubic metres, rates of return are in excess of 100% with payouts of 14 to 20 months. These are compelling economics.

In summary, Turkey has the potential to significantly increase its natural gas supply from unconventional sources – provided the favourable business climate remains and industry continues to invest capital in new ideas and new technologies. Given robust natural gas prices in Turkey in contrast to weak global oil prices at this time, the prospects are good that industry will continue to invest in unlocking Turkey’s unconventional natural gas potential.

James D. McFarland is President & CEO of Valeura Energy Inc. and a member of the WPC Congress Programme Committee (www.valeuraenergy.com).

▼ Figure 4.



Managing change and maintaining deepwater safety

The pace of technical change is exciting but safety standards remain a vital consideration for deepwater operators.

By Brian Salerno



These are truly fascinating times in which we are operating. Wherever offshore activity is taking place, the pace of technological innovation is astounding. We are seeing exploration and development today in regions and in formations that seemed impossible just a few years ago. With the emerging technology that is making this possible, we are challenged to match our thinking and our methods to the new realities, both as members of the industry and as regulators.

I visited Portsmouth, England, to see the *HMS Victory*, Lord Nelson's flagship at the battle of Trafalgar. *Victory* is the oldest commissioned warship in the world, first launched in 1765 and it is in pristine condition, representing the pinnacle of naval technology during the glorious age of sail. Across the dockyard is another ship, the *HMS Warrior*, also preserved as a museum. *Warrior* was

built in the mid-1800s, about 90 years later than *Victory*, and although she had masts and sails, *Warrior* was a steam vessel. The advent of steam propulsion was revolutionary.

And yet, what was striking in comparing the two ships, despite the revolution in technology, was how much of the old ways of thinking carried over into the newer age. An example was the arrangement of the guns. There were no turrets to swing guns in any direction. Instead, they were arrayed on *Warrior* along the sides, as they were on *Victory*. You had to point the ship to fire the guns. *Warrior* had revolutionary steam propulsion, which could manoeuvre irrespective of the wind, but they still thought in terms of sailing vessels.

This story is a useful metaphor for how we confront change. There is an inherent tension about it. On the one hand, it shows how the way we work

► While *HMS Warrior's* steam-powered engine was revolutionary much else about the vessel relied on paradigms from the age of sail.



and think about our professions does not uniformly keep pace with technological advances. We often apply old thinking to new situations because it has always worked before, even at the expense of foregoing new possibilities and potentially even driving up the overall level of risk.

On the other hand, this story shows a cautious willingness to incorporate new technology, but with a healthy dose of scepticism. The thinking is that perhaps it is better to take the time to experiment, understand limits and have an effective fallback position.

Either way, whether you are jumping feet first into new technology, or taking your time to fully understand it, risk is inevitable.

Today, we are used to a far greater pace of technological change. Forget a 90-year time frame – we grew up with Moore's law where we expect a doubling in computing power every 18 months. We are now comfortable with that rate of change.

We like technology. It opens new possibilities. When used properly, it keeps us better informed, improves communication, makes our lives easier and helps us manage risk. But it also represents greater complexity. Even though we can do things that were not possible a few years ago, do we always fully understand the margins of safety?

In the case of deepwater drilling, we are planning for wells which will use technology which has not yet been fully developed, and for which no technical standards have yet been devised. This is cutting edge stuff. The technology under development is extraordinary. The benefits will be immense.

But we need to examine how we accommodate change. We must be mindful of what this complexity represents for us in terms of risk, and seek to manage that risk as effectively as we can. As we have all seen, when complex systems fail, they tend to do so in spectacular ways.

Many events have had a profound effect on individual operators, entire industries, governments, and public perceptions and expectations. These include the fatal Piper Alpha explosion – out of it, the safety case approach was born. Other examples include the Montara oil field blowout, the Ocean



Ranger sinking, and the fatal explosion, sinking and oil spill from the Deepwater Horizon, and the Macondo field. From a business perspective, these disasters are damaging and their effects reverberate throughout the entire industry.

Public acceptance of offshore operations is fragile, as we have seen in the Gulf of Mexico, and as we are seeing in the Arctic. The term in use internationally is "social licence to operate". Acceptance is conditional – it has to be clean and safe.

Moreover, a dramatic failure by one operator tarnishes the entire industry. Everyone is blamed, including the regulator – because we are the ones the public depends upon to look after their interests. So, when it comes to managing risk, we are all in this together. We have a shared interest in safe and environmentally sound development of energy resources.

Safety culture

For the past several years, there has been useful dialogue and hard work to establish the framework for a meaningful safety culture. I characterise the basic philosophy as being one where the primary owners of the risk are the operators, and therefore the operator must bear primary responsibility for managing it. This is the current philosophy in most countries where offshore activity occurs, even

▲ Seen from space the extensive damage to the Gulf of Mexico from the Deepwater Horizon oil spill is evident.



▲ Exposed to the seas and unpredictable weather patterns, ensuring the safe operation of offshore installations is of paramount importance.

though the specific methods used to encourage and gauge the presence of a meaningful safety culture varies.

In the US, we approach safety culture through our Safety and Environmental Management System (SEMS). This was a post-Macondo development, which seeks to adopt some of the same characteristics found in the safety case approach used elsewhere. We require the operator to develop a SEMS plan suitable to their activities, implement it, and undergo periodic audits by third parties.

The SEMS process supplements our own government inspections of offshore facilities, which are undertaken to ensure a baseline compliance with minimum standards. It is a hybrid approach that preserves the government inspection component in conjunction with the performance-based SEMS requirement. It recognises that compliance with prescriptive standards will only get you so far. It verifies the condition of vital safety systems, but doesn't get to the heart of safety culture. So SEMS adds that performance-oriented component which places the burden on the operator to think through their safety processes.

One can debate all day about the relative merits of various ways to approach offshore safety, whether it be a compliance-based regulatory approach; the pure safety case approach in use in the North Sea and elsewhere, or a hybrid approach. Regardless of the system in use, I am confident most would agree

on the desired outcomes sought via regulatory efforts. However, I do not believe we will see complete harmonisation between regulatory regimes. We all work in unique social and political environments, where public expectations shape the way we operate. Our methods are subject to scrutiny and approval. As regulators, our currency is public trust. We are held to account based upon those expectations. So methods are bound to be different.

Our situation is a bit like the transition from sail to steam; we are keeping the sails just in case. However, I do believe there is very little difference in the safety effects we are seeking to achieve, and therein lies the common ground between regulators, and with the industry we regulate. The one thing that holds true, regardless of the regulatory system in place, is that there is no escaping the importance of the individual operators' commitment to safety. It has to be real, not just a plan on a shelf. It has to start with leadership and permeate down to the workers on deck. And workers must think and act in a safety-conscious way, even when no one is looking over their shoulder, and they must be supported when they stop work for safety reasons.

The point of safety culture is that it embraces not just technology, but the human element as well. People are part of the work process; they interact with the technology, derive data from it, make decisions based upon it. Human beings are also balancing competing pressures: Do I follow every step in a prescribed procedure and risk not meeting cost and schedule demands, or can I skip a step and make up some time? One wonders how many people wish they could have a "do over" in their response to that question. How do we protect against someone just having a bad day? We all have them. And as system managers, or as regulators, we need to assume that they will occur.

HROs

To move the discussion of safety culture to the next level, where systems, standards, procedures and people are linked in a more integrated way, I am

drawn to the approach used by high reliability organisations, or HROs. Some of the most technologically sophisticated industries and organisations in the world are following this approach to make their safety programs more robust, and they have shown dramatic improvements in their safety performance, the ultimate measure of worth for any safety system.

One of the core attributes of an HRO is the pre-occupation with failure – the focus on what can go wrong, strengthened by the assumption that at some point, it will fail. And when it fails, there will be consequences. Proceeding from that assumption, the question then becomes: how do you build in enough redundancy and internal controls so that when it fails, it fails safe?

There are many examples of how HROs have approached this. One of the most often cited examples is the US Navy's SUBSAFE programme. The SUBSAFE programme was instituted after the loss of the *USS Thresher*, a nuclear-powered submarine, in 1963.

Thresher was lost due to uncontrolled flooding during a test dive, which forced the boat to descend below its crush depth. SUBSAFE was established to prevent uncontrolled flooding. It looks at all system designs, material quality, and operational standards related to maintaining the integrity of the hull and preventing flooding. There is a rigorous series of certifications that underpin the system. And it has been effective. In the 50 years prior to SUBSAFE, the US Navy lost 15 submarines to noncombat causes; in the 50 years since SUBSAFE, they've lost only one.

One can look to other fields to see similar results, such as the nuclear energy industry and aviation. The US National Transportation Safety Board reported that the aviation industry achieved an 85% reduction in mishaps over a 10-year period, simply by focusing on system reliability, no-fault reporting and data sharing. That same focus on systems, including the human element, used as a way to manage process safety and control risk, is applicable offshore. Many companies in the offshore industry get this and are far along in integrating HRO

principles into their safety management approach. But, it is not yet universal, so the risk to the industry overall is still not fully addressed. The public trust that responsible operators are working to build and maintain, could be lost due to the failure of an irresponsible competitor. The entire industry is blamed when things go catastrophically wrong.

Addressing risk

As a regulator, I want to give meaning and rigour to safety management. Part of this is identifying and addressing risk as best we can, including targeting regulatory activities towards the greatest risks and riskiest operators. Collaboration with the industry, academia and standards developing organisations is vital in helping to identify and uphold appropriate safety margins for new technology. We also need to find ways where we can all benefit from increased information sharing and data analysis, so we never stop focusing on what can go wrong.

That is why we are embarking on a near-miss reporting system, in the expectation that we will learn more about system reliability, including the human component of complex systems. It is why we will continue to refine our SEMS programme, and share information and lessons learned with our international colleagues, and why we remain interested in learning from them. After all, we are interacting with the same companies, using similar technologies. It makes sense that we share what we are seeing.

Ultimately, we are all coping with transformational change. And unlike the shift from sail to steam, the pace for us is rapid and complex. We must continually question how best to manage change, from a technological and a human perspective. And whether we are members of industry or regulators, we have a shared interest in making safety systems as meaningful as possible. Our fates, in the court of public opinion, are intertwined.

Brian Salerno is the Director of the US Bureau of Safety and Environmental Enforcement (www.bsee.gov).



The evolution of the Operations Excellence Management System

A new approach to management has widespread benefits, including improved safety, revenue and productivity.

By Brett Doherty



Operations Excellence has become a popular concept in the oil and gas industry in recent years as leaders collectively agree its importance in improving efficiency, performance and organisational culture.

Although there's no universal definition, Operations Excellence can be inferred from a company's consistent high performance in the disciplines of personal and process safety, health, environment, security, equipment reliability, staff productivity, cost-effectiveness, as well as compliance with the law.

Achieving success relies on implementation of a management system, based on a continuous improvement cycle and a platform of risk identification and reduction that can only be effective if visibly and materially supported by all levels of management. Similar to safety culture, Operations Excellence represents an ethos that leadership must champion; the success of which is ultimately measured by broad, superior corporate

performance.

Never before has there been such a diverse range of demands on the industry. These include managing the traditional issues of occupational health and safety, security, process safety and the environment, meeting the expectations of communities, regulators, while providing sustainable value for shareholders and employees. Additionally, the emerging economic challenges of increasing investment in people and new technologies, amid resource constraints, with stronger global competition, create further demands for optimising all business aspects.

Going beyond boardroom ambition

In this current climate, Operations Excellence should deliver more than boardroom ambition. Effective embedding of Operations Excellence should deliver the competitive advantage, improved bottom-line margins and sustainable per-

► RasGas has operated the Alpha platform since 1998 with an exemplary safety record.



formance required of an enduring energy company. Remembering the old adage “you can only manage what you can measure”, how can organisations achieve excellence, a concept that is inherently imprecise and difficult to quantify using today’s accepted management system approach?

In the oil and gas industry, current performance benchmarking relies heavily on Health, Safety and Environment (HSE) metrics. However, it is clear that Operations Excellence addresses more than HSE performance – it must also focus on optimising production, reliability and cost while achieving high standards of corporate social responsibility and sustainable business practices.

Therefore, while HSE performance is necessary, it is not sufficient for Operations Excellence.

The oil and gas industry has hazards and risks that are inherent to its assets, activities, operational locations and products. Consistently applying a standardised approach to risk management across all types of operations can achieve a number of advantages: different sources and types of risks can be accounted for, including process and personal safety incidents; security threats; potential consequences of environmental impacts; and community grievances and critical skills shortages. Identification of opportunities for improvement, such as optimising fuel gas efficiency in a facility thereby conserving a scarce resource, or maximising production and thus revenues that brings economic and social development, is also a benefit that application of this approach provides. So, these principles, processes and management techniques can be applied to reduce risks and realise opportunities.

The importance of management systems

A structured and documented set of inter-dependent practices, processes and procedures used by companies to plan, direct and execute activities is known as a management system.

The development of management systems has somewhat reluctantly, but resolutely, tracked the lessons learnt from major accidents over the past 40 years. Evolving since the late 1980s, and initially



▲ RasGas operates seven LNG trains at its onshore facility.

focusing primarily on HSE, the management system is now considered the only reliable approach to address the oil and gas industry’s single, clear objective of continuing to improve its performance through systems for operating responsibly and managing risk while maintaining energy supplies.

The industry-changing Exxon Valdez incident in 1989 led to the genesis of Exxon’s ‘Operating Integrity Management System’ (OIMS) in 1992 – a more robust management system model. In the early 1990s, organisations such as the International Organization for Standardization (ISO), the American Petroleum Institute (API) and the Centre for Chemical Process Safety (CCPS) formalised this approach further through the publishing of management system standards and guidance. Although based on similar concepts, these varied in scope, covering areas such as environment, social responsibility, quality, process safety and offshore operations.

In 1994, the International Association of Oil and Gas Producers (IOGP) published their ‘Guidelines for the Development and Application of Health, Safety and Environment Management Systems (Report No. 210)’ as a basis for companies to establish systems to consistently manage HSE issues. Subsequent to this body of work, occupational health and safety performance notably improved for companies adopting the system.

However, the BP Texas City accident in 2005 shocked the industry into reforming the man-



agement system approach by requiring an explicitly stronger reference to process safety and a relentless focus on the effectiveness of the management system expectations at the coalface. Following the incident, several recommendations from the Baker Panel Report, which investigated process safety effectiveness within BP's US refineries, suggested that the integration of a more robust process safety management system into the existing HSE framework was required.

It is clear that the development of management systems has tracked major accidents over the past 40 years and the industry responded. Greater shared learning and an undeniable focus on improving HSE has reaped benefits, particularly with occupational health and safety performance.

The institutional folly in responding to major accidents to drive reformative change in management systems is obvious: an emotional event that may be devastating to employees, families, the environment and the community at large is too detrimental to all stakeholders to even rely on it occurring once, in order to recalibrate the approach. It's necessary to take note of fainter signals to avert impending major accidents, coupled with constant vigilance in regard to the adequacy of the company's management system.

The RasGas example

RasGas Company Limited (RasGas), a large liquefied natural gas producer in Qatar, has moved to address this. The company established a management system in 2002 by customising ExxonMobil's OIMS, which by that time had proven its efficacy in risk management.

The integrity of RasGas' facilities is assured through multilayered monitoring of the effectiveness of the management system – a requirement of the system itself. Effective, sustainable implementation is assessed periodically by both trained company assessors and independent shareholder experts. Dedicated management system specialists within the company provide ongoing support and advice as an integrated function of the operation.

The size and scale of the company's facilities have grown to an unprecedented level: RasGas' on-shore facility is the world's largest and most complex integrated gas processing facility ever built. Production has increased six-fold in the past 12 years. The leaders of the company were and continue to be committed advocates and owners of the management system's principles, its effective implementation and sustained execution. Necessary authority and resources were given to each level in the organisation to establish and implement the management system.

Responsibilities were defined through so-called 'system owners' who are held accountable in delivering performance in their assigned facet of operations integrity and HSE. This accountability has been cascaded throughout the organisation to appropriate levels of detail to the extent that plant operators should be aware of barriers to incidents and their role in maintaining the health of those barriers.

Is this significant effort justified through corporate performance and risk reduction? RasGas' personal injury statistics have placed it consistently within the top 5% of the industry over the past eight years, according to IOGP's annual Safety Performance Indicators Report. Similar improvements in performance across the other HSE disciplines can be seen when objectively benchmarked.

▼ Management systems continue to evolve, driving increased performance and safeguarding the workforce.





◀ The commitment of RasGas to Operations Excellence runs through every level of the organisation.

Recognising the utility in how the Deming-inspired continuous improvement cycle – Plan, Do, Check, Act – forms the basis of corporate HSE performance through successful management system implementation for RasGas. (William Edward Deming was an engineer and pioneer of management system implementation.) The company is now considering broadening the scope to formally incorporate the other elements of Operations Excellence, beyond HSE, within its management system. There is no doubt that incidental benefits to the thorough and sustainable application of management system principles, are improvements in equipment reliability, operating costs and indirect stakeholder benefits representing the wider concept of Operations Excellence.

A structured approach to Operations Excellence

A more structured embracing of Operations Excellence as part of an existing HSE-based management system seems not just logical, but necessary as oil companies face the challenges of today's global business environment.

The need for Operations Excellence has never been greater. Exploration, development and production costs are rising. Activity levels are increasing

with a commensurate increase in industry inflation. And with 25% of the industry's professionals retiring over the next seven years, a skills shortage seems likely to exacerbate this, both with direct operational staff and with services. The development of unconventional resources like shale and deep water oil require different processes for efficient extraction, posing unique operating challenges.

Other technologies such as floating liquefied natural gas (FLNG) production facilities and terminals are pushing the frontiers of Operations Excellence, where comparative guidance cannot be obtained through industry benchmarks. The loss of access to easy reserves, compounded by the foregoing, makes a structured adoption of Operations Excellence an imperative for oil companies today.

Organisations should be aware that the use of multiple management systems to address different classes of business risk may negate the effectiveness of each of these, through additional costs, inconsistent system application and obscuration of the critical threats to it. An integrated approach identifies business risks within a single framework, allowing local application for different operating contexts, with a standardised global reach.

In 2011, IOGP and International Petroleum Industry Environmental Conservation Association



(IPIECA) joined forces with a specialist task force of more than 40 industry professionals to create an Operations Excellence framework which focused on implementation, was flexible enough for organisations to adapt to their different operating assets and commensurate risks, but standardised enough to be used as a global framework ensuring consistency of application.

In 2014, two important documents were published: Report 510: The Operating Management System Framework with a guidance supplement Report 511 'OMS in Practice, which gives practical support to its implementation. This new Operating Management System Framework (OMS) was intended to help companies define and achieve performance goals and stakeholder benefits, while managing the broad and significant range of risks inherent in the industry.

The framework consists of ten elements defining "what to do" and four fundamentals on "how to do it". Each of the 10 elements contains five to eight expectations, each of which when adopted, may become auditable requirements for companies. Companies can extend the framework to increase controls on specific risks that are identified. It was designed to go beyond HSE, to include elements of social responsibility, quality and security, with a structure that could conform to further expansion into plant reliability and operating cost efficiency; an Operations Excellence management system. This approach gives companies the flexibility to adapt their own management systems to include any and all risks, including effects, impacts and threats associated with the elements of Operations Excellence.

It also provides the consistency needed for global benchmarking of performance, both for international oil companies to compare the performance of their multiple, inevitably disparate business units, and companies to benchmark performance against other companies using the framework. Conformance of a contractor's management system to the operator's is more easily ascertained and global standards for industry contractors are more

easily established if the framework was itself to become a standard.

Industry regulators representing the various governments with stake in the industry now have the benefit of requiring operators and contractors to conform to the framework, allowing more consistent auditing and identification of those companies underperforming within its jurisdiction. Finally, sharing of best practices within the industry is surely bolstered by the use of a common framework and management system terminology.

Management systems have demonstrated their efficacy in successfully managing a range of HSE risks inherent to the oil and gas industry over the last two decades. The most important and material improvements to management systems have followed what the industry has learned from investigating its major accidents. Management systems continue to evolve to drive company performance beyond the elimination of HSE-related incidents.

The Operations Excellence concept includes HSE performance as a subset of a greater set of controls over business-related risks. Building the elements of Operations Excellence into a management system will further improve industry performance and reduce the prevalence of major accidents. The pan-industry adoption of IOGP's framework would realise myriad benefits for all stakeholders: fewer major accidents, more efficient use of resources, increased sector profitability, and consistent demonstration of licence to operate by industry through improved transparency with regulators because of a common management system language.

How companies will adapt their existing frameworks remains to be seen, as indeed will developments on how the framework recommended in Report 510 can be adapted to include cost optimisation and human capital management, but this next step in the evolution of management systems can surely deliver real performance change and efficiency for all.

Brett Doherty is Chief Safety, Health, Environment and Quality Officer for RasGas Company Limited. (www.rasgas.com).



Committed to safety and the environment

Fostering a corporate culture that prioritises safety and the environment is an essential requirement for the sustainable development of petroleum resources.

By Jaime Martín Juez



▲ Jaime Martín Juez:
Repsol aims to achieve zero accidents by 2020.

Repsol's Board of Directors has a firm commitment to safety and the environment; a commitment honoured in all the countries in which the company operates.

Safety and environmental (S&E) concerns are fully integrated in our corporate decision-making process with S&E objectives set for all of Repsol's business units and corporate divisions.

Reaching out to every single employee in a practical, tangible and material way to prioritise S&E concerns is undoubtedly one of Repsol's greatest achievements.

Zero accidents

Repsol has a clear aim in relation to safety: to achieve zero accidents by 2020. We are aware that this is an ambitious objective and that it will force us to become quite demanding of our performance, but we are convinced that it is possible, and belief is essential in order to attain success.

We have gone far in relation to accident rates, but there is still a long way to go. We are making particular efforts to reduce road accidents, focusing especially on the accidents that our contractors have. All these efforts have contributed to a considerable reduction in the number of accidents, but we know that we must carry on improving. In order to do this it is essential to carry out comprehensive research into incidents. We must be aware that each incident is an opportunity to learn what has caused it and how to avoid its recurrence.

But in order to achieve zero accidents we must go further still. At Repsol, we are focusing on reducing accidents in our processes and premises, because these are where accidents can escalate, with dire consequences.

Better use of natural resources

We are committed to the efficient use of natural resources, the reduction of the disturbance of the natural environment and the reduction of the impact on neighbouring communities. We are aware that if we use less energy, we generate less waste and as a result we use less water and become more competitive and efficient. We consider protecting the environment to be a key element in the development of our activities; this protection must be linked to the capacity to innovate and to improved competitiveness.

At Repsol, we are committed to the development of a new model which secures a sustainable energy supply. This means making the most of available sources, optimising the use of present ones via energy efficiency and developing new types of energy with lower greenhouse gas emissions.

We have been working for many years on energy-efficient management. We have made important progress and achieved ambitious objectives in the reduction of CO₂ emissions. But we are still not satisfied and we have in mind new and more challenging objectives. Between 2006 and 2013, we reduced CO₂ emission by 3 million tonnes per year. By 2020, we want to reduce them by a further 2 million tonnes per year.

The reduction of waste is another of the pillars and objectives of our company. Efficient management of our processes will be linked to waste reduction. We have set ourselves quantitative and qualitative objectives with reduction pathways to 2020, as well as the implementation of best environmental practices.

For many years, Repsol has been working on improvement programmes for water management,



such as the optimisation of water usage and the minimisation and improvement of waste quality. Since 2012, we have categorised water as a strategic resource which needs to be managed based on an assessment of local risks.

We believe that we can only achieve these goals via a cultural change in relation to S&E. We will only achieve this by being the leaders, individually assuming that the responsibility of our own safety, that of others and the protection of the environment depends only upon us.

In Repsol, we believe that an advanced S&E culture is part of our company's valued-added proposal.

Leadership Plan

For this reason, we have been working on projects that ensure our position among the best S&E cultures in the industry. We feel especially proud of our Safety and Environment Leadership Plan.

Repsol's commitment to S&E is constant and has a long track record within the company. We believe

that a strong S&E culture should be developed in three phases.

In the first phase the focus is on technological aspects and on premises, incorporating best available technology in the design of processes and operations. The second phase focuses on the systemisation of performance via the implementation of integrated management systems. During the last phase we move towards a culture based on people's behaviours and beliefs.

In 2012, we set up an S&E Leadership Plan to improve the skills of our leaders and generate behaviours that set an example for others to follow. The S&E Leadership Plan has been designed with three fundamental pillars: training, development and communication.

Training

The aim of the training pillar is to provoke a change in attitudes and the most important initiative is PRISMA (Principio SMA). This is an experimental

▼ Repsol's \$3.5 billion project to modernise and expand its refinery in Cartagena included measures to reduce air pollution and optimise the use of water.



training programme which has been rolled out to more than 3,500 employees, including directors and managers. PRISMA has achieved the alignment of leaders, generated personal commitment around S&E leadership and created tools that facilitate the fostering of desirable behaviours by leaders in companies with strong S&E cultures. PRISMA was granted the Excellence in Practice Award 2013 by the European Foundation for Management Development (EFMD), under the Organisational Development Category.

Development

The development pillar supports the implementation of improvement plans and ensures that change becomes sustainable over time. We have adapted the objectives of our units and leaders to provide the professional development and coaching tools for our employees to face these new challenges.

Communication

The communication pillar raises awareness in relation to the relevance of safety and the environment. These matters must be a high priority for the company on a day-by-day basis, fostering a continuing dialogue, enriching corporate culture and encouraging learning. All of this will increase the level of personal commitment of employees. We therefore use a common slogan in our communications: "More committed: zero accidents".

Shared view

The initiatives included in the S&E Leadership Plan have allowed for a shared view in the whole organisation and provided leaders with the necessary skills to execute the strategy and involve employees.

As a result of this plan, Repsol leaders are deploying a management style based on understanding and developing an S&E culture based on people, and are making sure that safety and the environment are key factors in all the company's activities.

And we do not want to limit ourselves to this. We have already started an ambitious plan to take a new leap in the improvement of the S&E culture



through the development and periodical measurement of many factors which are part of the culture of excellence in S&E. We want a fair culture that reports and informs, a culture that learns, is flexible and which generates a sense of shared responsibility within all of us.

Jaime Martín Juez is Director of Safety and Environment at Repsol (www.repsol.com).

▲ Repsol's employees are committed to safety and the environment – onboard the *Rowan Renaissance* drilling ship.

WPC Vision, Mission and Values

The World Petroleum Council (WPC) is a non-advocacy, non-political organisation with charitable status in the UK and has accreditation as a Non-Governmental Organisation (NGO) from the United Nations (UN). WPC is dedicated to the promotion of sustainable management and use of the world's petroleum resources for the benefit for all.

WPC conducts the triennial World Petroleum Congress, covering all aspects of the industry, including management of the industry and its social, economic and environmental impact.

Vision

An enhanced understanding and image of the oil and gas sector's contribution to sustainable development.

Mission

The World Petroleum Council is the only organisation representing the global oil and gas community. WPC's core value and purpose centres on sustaining and improving the lives of people around the world through:

- Enhanced understanding of issues and challenges
- Networking opportunities in a global forum
- Cooperation (partnerships) with other organisations
- An opportunity to showcase the industry and demonstrate best practice
- A forum for developing business opportunities
- Information dissemination via congresses, reports, regional meetings and workshops
- Initiatives for recruiting and retaining expertise and skills to the industry
- Awareness of environmental issues, conservation of energy and sustainable solutions

Values

WPC values strongly:

- Respect for individuals and cultures worldwide
- Unbiased and objective views
- Integrity
- Transparency
- Good governance
- A positive perception of energy from petroleum

- Science and technology
- The views of all stakeholders
- The management of the world's petroleum resources for the benefit of all

Key strategic areas

- **World Class Congress** to deliver a quality, premier oil and gas congress.
- **Inter-congress activities** to organise forums for cooperation and other activities on specific topics; and to organise regional events of relevance to WPC members and all stakeholders.
- **Cooperation with other stakeholders** to add value by cooperating with other organisations to seek synergies and promote best practice.
- **Communication** to increase awareness of WPC's activities, through enhanced communication, both internally and externally.
- **Global representation** to attract and retain worldwide involvement in WPC.
- **Youth and gender** engagement to increase the participation of young people and women in oil and gas issues, including the establishment of a dedicated Youth Committee for the development of active networking opportunities with young people.
- **Legacy** to manage a central WPC legacy fund to benefit communities and individuals around the world based on WPC's mission.

World Petroleum Congresses

2017 22nd WPC Istanbul					
2014	21st WPC	Moscow	1979	10th WPC	Bucharest
2011	20th WPC	Doha	1975	9th WPC	Tokyo
2008	19th WPC	Madrid	1971	8th WPC	Moscow
2005	18th WPC	Johannesburg	1967	7th WPC	Mexico City
2002	17th WPC	Rio	1963	6th WPC	Frankfurt
2000	16th WPC	Calgary	1959	5th WPC	New York
1997	15th WPC	Beijing	1955	4th WPC	Rome
1994	14th WPC	Stavanger	1951	3rd WPC	The Hague
1991	13th WPC	Buenos Aires	1937	2nd WPC	Paris
1987	12th WPC	Houston	1933	1st WPC	London
1983	11th WPC	London			



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The bright future of India's petroleum industry: Essar (72), Cairn Energy plc (73).

Overview of the Russian oil industry: Challenges and prospects: Rosneft (76), OAO Gazprom (80).

Engineering progress and possibilities: Chevron Corporation (84 and 87), Transocean (85), Adrian Giddings/ISC (86).

The WPC Youth Survey 2014: OAO Gazprom (89), The Oil Sands Leadership Initiative (90).

Future prospects for Angola's oil and gas production: Tako Koning (92 upper), Harald Pettersen/Statoil (92 lower),

Ari Versiani/Petrobras (93), Adrian Giddings, ISC (94).

The role of the European refining industry in developing cleaner fuels: FuelsEurope.

US unconventional energy development and the use of industry standards: API (100), Ole Jørgen Bratland/Statoil (101), Cheniere Energy, Inc. (103).

FLNG – F is for floating and flexibility: Royal Dutch Shell (104), Wison (105), Excelerate Energy (106), Høegh LNG (107 upper), Golar LNG (107 lower), OLT Offshore Toscana (108).

FLNG – A game changer for the industry: Petronas.

Unlocking energy efficiency: a win-win strategy: Saudi Aramco.

Leading the industry on climate change: IPIECA (116 upper and 119), Shutterstock (116 lower), United Nations (117), Damián Bakarcic* (118).

Taking the chill out of Arctic operations: DNV GL (120 upper and 122 lower), Michael Cameron, NOAA/NMFS/AKFSC/NMML (120 lower), Adrian Giddings/ISC [adapted from material taken from The CIA World Factbook] (121), Arstein Rønning* (122 upper), OAO Gazprom (123).

A case study for sustainable development in Peru: Hunt Consolidated, Inc.

A Turkish perspective on unconventional gas: Valeura Energy Inc.

Managing change and maintaining deepwater safety: US Bureau of Safety and Environmental Enforcement (132 upper), Charles D P Miller* (132 lower), NASA (133), Harald Pettersen/Statoil (134).

The evolution of the Operations Excellence Management System: RasGas.

Committed to safety and the environment: Repsol.

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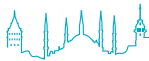
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