

# CHALLENGES & OPPORTUNITIES FOR THE NEXT 30 YEARS *Innovation & Competition*



**ADNOC ADIPEC 2014**





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# Recruitment, Development & Retention: Building the UAE Energy Industry's Future Workforce

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**By Mohamed Sanad Al Qubaisi, Deputy HR  
Director, ADNOC**

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**The global oil** and gas industry is facing a resource crunch as an ageing workforce is not replaced quickly enough with new talent. Existing shortages of experienced petroleum engineers will become even more pronounced in the coming years as a larger share of the existing workforce reaches retirement age. The skills shortage in the oil and gas patch is frequently cited as one of the biggest challenges facing the industry around the world, with some 50 percent of petroleum engineers set to reach retirement age by 2025.

The Gulf region faces very distinct demographic challenges when it comes to national talent development. For some countries in the region, the citizen population is too small to support the economy, so skilled labor must be imported; in other countries, high population growth leads to a large youth population that must be educated and transitioned to productive work.

This raises questions over how to ensure sustainable growth and development in various industries and sectors, especially in oil and gas, where specific skill sets will be increasingly scarce and in high demand in the coming years in resource-rich countries like the UAE. The key is to build and develop the national talent capacity required to meet the challenges and opportunities of the future.

As a key contributor to Abu Dhabi's economy, the oil and gas sector—which in 2013 accounted for about 55 percent of the emirate's gross domestic product (GDP)—is as dependent on attracting and retaining new talent as it is committed to developing national talent. ADNOC as the national oil company sits at the heart of this strategy.

Today, ADNOC—together with other local stakeholders—plays a seminal role in developing local talent from as early as pre-school level through to university. The group, which includes a holding company owned by the government and 14 units that operate in all sectors of the oil and gas industry, has been on an aggressive recruitment drive since 2010 that has led to the doubling of its staff levels to above 50,000 people.

The new employees are overwhelmingly Emirati, recruited from national training institutions including the ADNOC Technical Institute and the Petroleum Institute. Respectively, these are a vocational college and a specialized university that ADNOC founded with industry and academic partners to meet its future requirements for technical staff. Currently, 51 percent of ADNOC's total work force consists of UAE nationals.

ADNOC has become a strategic partner for the UAE government in employing UAE nationals across the entire country. The company, which is one of the world's top-10 largest oil and gas companies by production, is committed to offering unique opportunities to talented UAE nationals in all areas of the organization and this is demonstrated by its compelling incentive programs, nationalization strategies and development programs.

Still, the success or failure of the national energy industry will not simply be the scale and speed of attracting new talent, but most importantly the retention of that staff will be the benchmark.

The retaining of great people in the future will depend heavily on mentoring, on whether or not line managers are setting great examples as coaches - whether they're spending their time encouraging, supporting and helping the ambition of new recruits. ADNOC recognizes the importance of the personal relationship between people in an organization is critical, especially after such a significant recruitment drive as we have experienced over the last five years.

Attracting more women to what remains a male-dominated industry will be equally important if the industry wants to fill its widening talent gap. Thousands of women are breaking ground in energy industry careers, with the majority of new university students entering engineering programs in the Gulf being young women. Yet, women still represent



a small share of the oil industry's workforce and even fewer hold engineering or other technical positions.

ADNOC's Petroleum Institute now boasts almost 50 percent of its 1,500 student body is female, up from no representation less than 10 years ago.

Moreover, stimulating interest among youth in engineering and science studies and in the energy sector will be seminal to ensure and sustain a flow of new engineers into the industry in the years and decades to come. Future talent power needed for global economic growth—and sustaining the energy industry—comes from men and women armed with STEM skills – advanced knowledge of science, technology, engineering and mathematics.

Competition for talent around the globe is becoming fiercer and fiercer, and the UAE is no different, as fewer newcomers are entering

the energy industry, choosing to work for more glamorous financial services or Silicon Valley IT businesses like Google instead. As a result, the recruitment, development and retention of talent has been pushed right to the top of energy companies' agendas, in particular in the oil and gas sector, where the development of new hydrocarbon resources is becoming increasingly complex and technically demanding. [5](#)

*“Competition for talent around the globe is becoming fiercer and fiercer, and the UAE is no different, as fewer newcomers are entering the energy industry, choosing to work for more glamorous financial services or Silicon Valley IT businesses like Google instead.”*



# PANEL DISCUSSION: TALENT SHORTAGE: FILLING THE GAP

**PANELISTS:**

- **Mohamed Sanad Al Qubaisi**, Deputy HR Director, ADNOC
- **Dalya Al Muthanna**, President & CEO, GE Gulf
- **Dr. Yehya Al Marzouqi**, Strategic Development and Learning, Tawazun
- **Richard Doidge**, Managing Director, Maersk Oil Middle East

Moderator: **Sean Evers**, Managing Partner, Gulf Intelligence

**SEAN EVERS (SE):** Today we're tackling the subject of talent shortage facing the industry and how we fill the gap created by some 50 percent of the industry's petroleum engineers due to retire in the next decade. I'm honoured to have a distinguished panel join us today. I'm going to start with our host Mohamed Sanad Al Qubaisi, Deputy HR director for ADNOC. I think it's quite interesting we're having this conversation now. In recent years we have seen ADNOC staff nearly double in size. That is a great success on one level, but inevitably a great challenge.

**MOHAMED SANAD AL QUBAIS:** Thank you. Over last 10 years we have launched massive projects which have given us advantages on how we challenge our manpower planning alongside training, development and retention. We have maximized our five-year rolling business plan to achieve our target which stands at 75 percent of Emirati employment in the company by 2015. Today we are at around 45 percent but we have a good number of graduates in the pipeline. At the same time, we have good opportunities to train our nationals on new projects, both offshore and onshore. Here we have the opportunity to deploy them, integrate them and starting them on projects from early stages.

**SE:** Given staffing increases and the target to Emiratis to that level, what are your main tools to attract them?

**MOHAMED SANAD AL QUBAIS:** I think we've become known for training and development and retention and career progression, where we have



really a good history with our partners and we've tried to capitalize on that.

**SE:** How much do you rely on compensation levels to trump your competitors?

**MOHAMED SANAD AL QUBAIS:** This depends on at what stage we're talking about. Currently we are within the industry in terms of scale. Over the last few years maybe we've been a little bit up and down. But again, we place much emphasis on retention through welfare. We try to be a pioneer in retaining people. Again, the financial package will not always be the only factor.

**SE:** I'd like to bring in Dalya Al Muthanna, President and CEO of GE Gulf. You are in every sense a role model and an example of the new generation of Emiratis. GE stands across multiple verticals. Oil and gas is one. How do you see the situation vis-à-vis talent, national talent, as well as just the availability of talent across all sectors to meet your business goals?

**DALYA AL MUTHANNA:** At GE, we spend approximately \$1 billion annually on training and developing our employees. We work with various partners like ADNOC to build training

models addressing specific skillsets. This is quite important for GE as we believe that one of the best ways in attracting and retaining talent is through investing in their growth and development. For instance, in GE, we have an oil and gas university in Florence where we had sent around 30 engineers from ADNOC. We also have collaboration with the Petroleum Institute where we've trained approximately 90 engineers from ADNOC. As a national, I feel proud of such initiatives.

**SE:** It is a big issue to attract national talent into the private sector as opposed to government jobs. Could you share your personal thoughts on this? What guided your own choice?

**DALYA AL MUTHANNA:** One of the key challenges is the lack of awareness and understanding of what the private sector can offer in terms of career development and training. Working for a company like GE, you can benefit from different experiences and rotations by working in other parts of the world. I was on a rotation in the U.S. for six months, working in Atlanta at our Power & Water headquarters. The experience there has enriched my personal leadership skills a lot. A lot of nationals aren't aware of the potential for career growth in multinationals. The government is strongly encouraging the enrollment of national into the private sector; Sheikh Mohammed bin Rashid, UAE Vice President and Prime Minister and Ruler of Dubai, has put a target to increase the number of nationals across the private sector by tenfold in the next seven years.

**SE:** Turning to Richard Doidge, Managing Director, Maersk Oil Middle East. Maersk Oil is a very big player in Qatar, dealing with Qatarization and the nationalization challenges there. What have you learned?

**RICHARD DOIDGE:** Qatar is our largest upstream business unit in the region. Qatarization has been very successful for us. We have a 50 percent target and now we're at around 23 percent. That's close to 200 Qataris in the workforce. Retention is the key. One of the things that we as an oil company have been offering for

*'I think the alignment between academia and society and industry is what's needed.'*

**MOHAMED SANAD AL QUBAIS**

the past few years is a bespoke training program, which is based on a similar program which has been running for many years in the Maersk shipping company. This was adapted a few years ago into what we call the MITAS program which stands for Maersk International Technology and Science. It is a two-year program with three eight-month assignments in different business units. It's specifically aimed at engineers, geoscientists, and mainly technical staff. We've found that over the last six years or so 80 percent of the MITAS employees are still with the company. Clearly it demonstrates the opportunities that are available if you stay with Maersk.

**SE:** Stepping back a little, we're hearing a lot of noise on an emerging talent shortage and the potential crisis that it presents. What's your view? Is that overplaying it?

**RICHARD DOIDGE:** We've been talking about this for years. One of the big problems we have is that the industry is perceived by a lot of kids in school and students at university as old-fashioned, dirty and conservative. We still have much cutting edge technology and real innovation in the upstream industry but somehow that's not getting across.

**SE:** But you would share the view that this is an emerging crisis that the industry has to take?

**RICHARD DOIDGE:** Absolutely.

**SE:** I'd like to introduce Dr. Yehya Al Marzouqi, a long-time veteran of ADNOC and now working with Tawazun. How do you see this challenge in the context of your environment?

**DR. YEHYA AL MARZOUQI:** Thank you. The shortage of technical disciplines is not unique to our part of the world. It's a worldwide phenomenon. In the late '80s, early '90s, oil and gas was downsizing business process and engineering. The notion of downsizing was communicated to the kids in colleges and they changed their majors. Now there is a shortage of engineers.

**SE:** Given the current adjustments in the oil price I guess we shouldn't repeat the same mistakes.

**YEHYA AL MARZOUQI:** The issue is how to entice people at the elementary level, at the high school level into STEM: that is science, technology, engineering and maths. There are some sporadic programs going on. You know, ADNOC has a program with high school, we

have one. But it is not a collective effort.

**SE:** Do you think it's realistic for the industry to play an active role?

**YEHYA AL MARZOUQI:** I think it's a combination. It needs to be collaboration between government entities, academia and industry. They need all to create a consortium together to tackle the problem. The problem is compounded in a country when you are the minority. Our population, we're all aiming at 75 percent. We, in Tawazun are aiming at 60 percent.

**DALYA AL MUTHANNA:** I think that's a very important point. As government departments set their respective targets for Emiratisation for the next three to five years, these targets need to be communicated to educational institutions that can support these government departments in making sure that the right pipeline of talent is being built. The key to achieving the Emiratisation targets is to make sure you have all the right stakeholders engaged and working towards the same goals.

**SE:** What is more important at this particular juncture, attraction or retention? Certainly there are some national organizations putting out big compensation levels, boosting the proposition. Anecdotally, there are stories of some having to share desks because of so many new people coming in and experiencing frustrations. Mohamed?

**MOHAMED SANAD AL QUBAISI:** That's true. We've been aggressive in our intake given the level we need to reach. We have struggled with office space but we also have some solutions to push people to the operations side for more adequate, on-the-job training. As for the recruitment gap, we have two institutions such as the ADNOC Technical Institute. The PI Petroleum Institute is another source for ADNOC where we attract more nationals.

*"It is for senior leaders to get insights into the experience of women, to get ideas, suggestions, and recommendations of how we could help them to make sure that the female talent is being well supported and developed within the organization."*

**DALYA AL MUTHANNA**



*"The issue is how to entice people at the elementary level, at the high school level into STEM: that is science, technology, engineering and maths."*

**DR. YEHYA AL MARZOUQI**

**SE:** What do you think of the point Dalya made on the need for greater coordination between the private sector and national sector? What does coordination look like?

**MOHAMED SANAD AL QUBAISI:** I see a very promising future with regard to good engagement from the universities and schools. Our government is very keen on these requirements. So there is good engagement. We have MOUs with those trusted universities just to make sure that whatever they deliver, it is related to our oil and gas.

**DALYA AL MUTHANNA:** I think it's very important to highlight success stories from ADNOC to entice the students to want to follow through with this kind of career path.

**RICHARD DOIDGE:** I agree. If you want to hire and develop and retain good strong technical staff, you have to have a good technical career path and a good technical ladder, but you also need to celebrate the sort of high-flying technical engineers, geoscientists and so on. We also have mentor systems as well.

**SE:** Are there mentor programs in ADNOC?

**MOHAMED SANAD AL QUBAISI:** Yes. We have a list of certified mentors and they go through training courses. I think the alignment between

academia and society and industry is what's needed. We also need to reach out for the students at the colleges, at high school. It's that age you need to attract them to STEM. All of us, we are targeting universities. I'm afraid that's too late and too little.

**SE:** We have a question from the front. Please go ahead.

**UNKNOWN AUDIENCE MEMBER:** I would like to ask Dalya, you've mentioned that one of your strategies to retain talent is training and to customize training for individuals. Is it best to concentrate on discipline or is a training program for specific individuals?

**DALYA AL MUTHANNA:** We have both internal training and external training. External training is offered to our customers and can be customized to their needs. In terms of training that we offer internally, we have several leadership development trainings, for example we have the Edison Engineering program, the experienced commercial leadership program; and the finance management program. They are primarily two year programs but some can go up to five years.

**AUDIENCE MEMBER:** How do you ensure this investment is going to the right people?

**DALYA AL MUTHANNA:** We have what we call



the EMS employee management system—a kind of internal CV. At the end of the year, we look at the performance of each employee, we review his/her performance and we discuss development plans and look at what training and development we can assign to the employee to make sure we improve or uplift their skills.

**SE:** One of the issues is that of women and how they can play a key role in finding the solution to the talent shortage in the energy sector. At the Petroleum Institute, 48 percent of students are female. How significant do you think that is? Mohamed?

**MOHAMED SANAD AL QUBAISI:** We know that attaining 75 percent Emiratisation will not be successful without engaging women in our operations. I started this when I was at ATCO around five to six years ago. There were challenges. First of all, parents would not accept females going to the field. For example, the working overall was not acceptable for females. So we went the extra mile to ensure that it was certified by our (AWQAF) Ministry. Then we started with our culture, with regard to communication / awareness.

**SE:** So you see the biggest challenge is a cultural one rather than anything else?

**MOHAMED SANAD AL QUBAISI:** Now we have overcome that challenge. We used to have gender restrictions from certain companies with regard to their intake. This was something that we have really pushed back and encouraged companies to engage women. At Ruwais, we have a female-friendly environment atmosphere. There's no issue now seeing females on site, around the wells, doing maintenance and so on. It's become a habit now.

**SE:** Dalya, I'd welcome your thoughts on women play an increasingly significant role in the energy industry.

**DALYA AL MUTHANNA:** I think women are definitely on the right track. I think it varies from one country to another but the UAE has been very progressive. We have woman ministers, CEOs and entrepreneurs. I think we're progressing very well.

**SE:** But there are issues. For example in Saudi Arabia, 70 percent of the science students are women, but only 1 percent of researchers are women. They are performing well in school and university but the talent pool isn't growing.

**DALYA AL MUTHANNA:** We have to take into consideration that whether a women takes up a career or not is a personal choice, some women choose to be full time mothers. I think it is our duty to make sure the opportunity for every woman to have a successful career is there but at the end of the day it is an individual decision.

**SE:** If anybody would like to comment, please put up your hand.

**UNKNOWN MALE AUDIENCE MEMBER:** When we recruited woman, we didn't want to have a situation where children are being raised by maids. So now we make sure we create nurseries on site and we ask mothers to go every two hours to see their kids so there is a bond between the children and their mother.

**RICHARD DOIDGE:** One of the things we try to do where possible in Qatar is to adapt a kind of unique rotational schedule so that female engineers and others can undertake one-day offshore visits at a time. We find that is much more accommodating.

**SE:** Another question here.

**UNKNOWN MALE AUDIENCE MEMBER:** I'm curious to know how companies are managing the transition from a large number of expats to a large number of locals. Are companies risking losing expertise if they don't do this transition correctly?

**MOHAMED SANAD AL QUBAISI:** Whenever a graduate comes in, we have a program called CAMS – Career Assurance Development program. With that we target any job that is critical and we design the CAMS program to replace those reaching 60, whether expat or UAE nationals. And we have very comprehensive model, an automated Emiratisation program. At the age of 55, it will alert HR and talent management that we have to take action within the next five years before that individual retires.

*"If you want to hire and develop and retain good strong technical staff, you have to have a good technical career path and a good technical ladder, but you also need to celebrate the sort of high-flying technical engineers, geoscientists and so on."*

**RICHARD DOIDGE**



**YEHYA AL MARZOUQI:** Organizations are expanding. We are diversifying the economy. There is always a need for expat mentors and coaches. I don't want to create an organization of fear within the organization. And now I have people who are expats who are over 60 and then they have 10 Emiratis they are coaching and mentoring.

**AUDIENCE MEMBER:** Having a proper, competency-based development program in place, having a good coaching and mentoring in place doesn't happen overnight. And some will say, "Why should I transfer knowledge? The faster I transfer knowledge, the sooner I exit your organization. What is in it for me?"

**SE:** Dalya, in terms of GE, do you have any mentoring program where knowledge transfer is a structured strategy?

**DALYA AL MUTHANNA:** Yes we continuously seek mentoring opportunities for our employees. We also have reverse mentoring which is an initiative led by GE's women network. This is where women would mentor more senior male colleagues. It helps senior male leaders to get insights into the experience of our women employees within the organization, as well as get ideas, suggestions, recommendations on what more can be done to ensure that the female talent is being well supported and developed within the organization.


**SE:** I'd like to move onto closing comments now. Richard?

**RICHARD DOIDGE:** Picking up again on the industry's image of being old-fashioned, we

have this thing going on in the ADIPEC Youth Pavilion – a computer game called the Quest for Oil which is something that we introduce into schools. This is our attempt at trying to make the oil industry an appealing and cool thing for school kids. It's not Minecraft but it's pretty good.

**DALYA AL MUTHANNA:** I'd like to add one more thing about innovation within the oil and gas industry. I think the trend towards big data, data analytics, software meets hardware and the ability of machines to speak to each other, brings a big change to the industry and I think that there is a huge potential of growth in that aspect. I think it would be great if we could highlight that to our high school and university students, to show them that these traditional industries can be very innovative and high tech and is something to look out for as it will change the industry we are working in today and the workforce in general.

**SE:** Mohamed, our panel host, I'd particularly be interested in what you think ADNOC's greatest HR challenge will be in the next five years.

**MOHAMED SANAD AL QUBAISI:** I thank everybody for really giving a good insight and added value to our discussion. I see ADNOC is coming straightforward and within five or 10 years, we'll be filling the gap with regard to PI scholarship. As we speak, we have almost 3,000 students studying here locally and internationally. We have expanded to Korea, China, Japan, Germany. The challenge for us is to have a strong leadership in the future. If we are able to really raise that leadership, I think we will continue our success further. 



## **Enhancing Energy Efficiency for Producers & Consumers - What is the Industry's Role?**

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**By David Keat, VP Technical & Engineering Support, Al Hosn Gas**

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## With growing populations

around the world and soaring demand for power and water, the real challenge lies in how to provide for the growing consumption using less energy. According to estimates, energy needs around the world are set to double by 2050 and therefore far-reaching efficiencies will be increasingly required if affordable energy is to be secured for future generations.

Becoming more energy efficient is achieved essentially through reducing the amount of energy wasted; both on the demand side – through management tools and systems – and on the supply side by creating optimum efficiencies in power generation, distribution and consumption in industries and households. The reality is that savings made don't just reduce the amount of raw material needed but can reduce costs throughout the supply chain, ensuring less upward pressure on energy cost trends whilst deferring or offering an alternative to the next large-scale power generation investment.

Rich in oil and gas, the Gulf region has in recent years undergone a transformation and is now emerging as a major consumer in its own right. The annual increase in demand in Abu Dhabi is for example estimated at 10 to 11 percent. The Emirate is currently chasing that curve with pioneering development projects to produce more of its own gas, which drives its power generation almost single-handedly. For example the Shah gas field, developed by Al Hosn Gas, a joint venture between ADNOC and Occidental, will provide some 500 million standard cubic feet per day of gas and reduce the UAEs dependence on gas imports from Qatar.

At the producers end, industry experts say a holistic approach is required to assess the UAE's energy needs and the best ways to meet them. Taking the US for example, producer energy efficiency improvements could yield gross savings worth more than \$1.2 trillion, well above the \$520 billion needed in upfront investment, according to McKinsey. The reality is that the business case is there. More efficient plants cost less to run and generate higher revenues.

Communication and collaboration is key and can lead to transformational change in how energy resources are created and how they are utilised. Inevitably, that also means a close focus on aligning political and business agendas, a task that takes considerable time and effort. But if the vision and will is there, there is much that governments can do to foster an environment of innovation and best practices and lead their societies towards joined up energy efficiency

strategies. Abu Dhabi's water and energy provider ADWEA has for example created initiatives for desalination companies to set up small pilot plants to test new technologies which could open doors to future transformational change. Encouragement needs to be given to the private sector to explore new solutions. Brave strategies can often lead to the biggest rewards.

What about the consumer side? Historically, utility bills for households in the Gulf region have been very low due to heavy subsidies provided by governments. This is an area that many agree is a real issue which if addressed could offer real results. After all, the best form of efficiency is to reduce demand. In societies where bills are much higher, people keenly recognize the incentives to cut their energy usage and cut their own expenditure as a result. Inevitably that brings down the demand curve and impacts the levels of energy the authorities need to generate.

Some steps have been taken. Dubai first introduced a tariff structure in 2008 and increased tariffs in 2011 that have led to significant price rises. Utility bills in Abu Dhabi now break down household consumption and tariffs will be introduced at the start of 2015 that will see modest price increases.

It isn't simply a matter of cranking up energy bills and hoping people will become more savvy about energy efficiency. On the supply side producers tend to drive their own efficiencies through legislative requirement or by continuously implementing energy saving initiatives with high financial returns. On the demand side the challenge is much more complicated as it requires a change in individual behaviours.

The role of education is crucial here to ensure that the public becomes aware of the value of energy and water and the goal of creating a more sustainable world. But education needs to be backed up with measures that can help drive change and not just hope that become people more aware and use less power. This is certainly the case if energy prices remain low in some Gulf countries and many continue to have an attitude to excessive consumption as "not my problem".

New regulations can play a major part. A key area here is the use of building codes, requiring new buildings to adhere to construction design with greener credentials. This is a step change that will deliver significant reductions in demand without requiring massive additional expenditure. The energy savings provided for both commercial and residential builders alike can offer financially favourable rewards.



This is where the role of sophisticated technology comes in. On the supply side technological advances have led to major advances in extraction in recent years. Take Abu Dhabi's Shah gas field, an ambitious project to process very sour (high hydrogen sulphide content) gas which would not have been possible a decade ago. Take hydro-fracturing that has come on leaps and bounds since 2006. Research and development undoubtedly needs to be at the core of all companies in the energy industry to instill the importance of innovation. Sophisticated monitoring technology will be a major area of future improvement. Whether in processing plants or in residential homes, sensors can provide valuable real time insight into energy consumption by tracking leaks or inefficiencies quickly allowing plant or home owners to quickly respond. Equally, new technology and technical innovation can steer most efficient practice in enhanced oil recovery techniques which are heavily dependent

on either large-scale gas or water use and which have an impact elsewhere in available energy or water capacity.

Boosting energy efficiency is intertwined with the goals of more efficient water management. The amount of fresh water consumed for world energy production, for example, is on track to double within the next 25 years, according to Paris-based International Energy Agency (IEA) projections. This critical nexus between energy and water must also be addressed and clearly, working towards solving these challenges are paramount. Progress has been made in recent decades but the quest for better energy efficiency needs to continue at an even quicker pace to ensure that we hand over a world that is well supplied with efficiently sourced power and water to future generations. Governments can set the parameters to the industry but it is clear they won't succeed unless we, the consumers join them in pushing forward real progress. [5](#)



## PANEL DISCUSSION: SMARTENING UP – HOW TO DRIVE GREATER ENERGY EFFICIENCY?

### PANELISTS:

- **David Keat**, VP Technical & Engineering Support, Al Hosn Gas
- **John Wishart**, President, LR Energy
- **Adrian Creed**, Partner, Clyde & Co
- **Omar Mohammed**, UAE Country Director, Baker Hughes

**Moderator: Marcus George**, Associate Editor, Gulf Intelligence



**MARCUS GEORGE (MG):** Today we're talking about energy efficiency and what the role of industry should be. It is of course a very important subject with growing populations and a soaring demand for energy around the world. The challenge is how to provide for that soaring demand with less energy. The UAE is an interesting case study in its own right. Its demand is growing by around 10 percent a year. Before hearing from our panelists I'd like to open the floor to our host David Keat - Vice President, Technical and Engineering Support for Al Hosn Gas, an ADNOC company.

**DAVID KEAT:** Thank you. I think ADNOC is quite advanced in terms of energy efficiency and conservation and environmental matters generally. At the highest level ADNOC has a code of practice, which all the operating companies are required to adhere to. That outlines what we need to do in terms of energy efficiency, water conservation, from design all the way through to the operating phase. As individual operating companies, we need to report our performance to ADNOC. It acts as a quasi government type of authority guiding what we do.

**MG:** Looking at ADNOC itself, what is the business case for it to become more efficient?

**DAVID KEAT:** There are two main drivers. Producing companies are generally very large. For the oil and gas industry we are usually burning our feed stock to meet our energy needs. If we don't burn that feed stock, we can sell it as a product. So there's usually a strong business case

for energy efficiency and that drives year-on-year improvements. The other strong driver is ethical or sustainable considerations. ADNOC companies are driven by that as well. We may make decisions which are not strictly economic, but because they're the right thing to do.

**MG:** Turning to Omar Mohammed, UAE country director for Baker Hughes. Omar, you've worked a great deal on the technical side. Where do you think the importance of innovation lies in progressing energy efficiency?

**OMAR MOHAMMED:** Thank you. Concerning the energy requirement for 2040, demand is set to grow 40 percent. So we have put emphasis on more research and development. With advances in technology, we have seen real progress. Using the latest technology we can go to 30,000 feet, including horizontals. We can frack and we don't need to use water anymore. We can use chemicals. These are major advances. In the US, they started to frack in 2006 at a rate of five to 10 stages. Now we can do upwards of 40 stages and can drill 30,000 feet horizontal wells. But the key point is we need energy. Of 7 billion people, 1.3 billion don't have access to electricity and we must ensure that energy is affordable for everybody.

**MG:** Let me turn to John Wishart of Lloyd's Register, Energy. What does government need to do to promote better energy efficiency?

**JOHN WISHART:** I believe the key is looking at the issue in a holistic sense. If you focus on individual parts you create unintended consequences. Omar is right: technology is going



to be a huge enabler for this. But we need to look at where we are applying to technology. This requires the holistic view of what are we using in terms of overall energy and then getting that balance right. That balance will lead you to the right strategies. All companies are building more efficient plants. We now need transformational change. And I think that's going to require a lot of collaboration across end-users, producers, and education will be needed too.

**MG:** That's the key word isn't it, collaboration? How difficult a challenge is that?

**JOHN WISHART:** It's about getting the political and business agendas aligned. We have to change the way we work. It's going to require a lot more discussion. And that will then give us the joint strategy for how can we help society have the energy it needs at an affordable price and deliver it as efficiently as possible.

**MG:** I'd like to bring in Adrian Creed from Clyde & Co. Looking on the consumer side, clearly we have big consumption here of energy and water and it's not helped by subsidies. How do you see those challenges?

**ADRIAN CREED:** Right across the MENA region, historically utility bills have been very low and haven't reflected actual consumption. But now when you get your bill in Abu Dhabi, it will tell you what you've consumed and what your subsidy is. This is softening people up for the reality that there is a cost to all of this.

**MG:** And I suppose that's more feasible in the UAE, where you have government entities which have stakes in many projects. But what comes next? What about energy bill reforms?

**ADRIAN CREED:** Abu Dhabi already has different tariffs. Oman has actually been leading the way in many respects. They are now saying to producers who come in and develop power and water facilities that the end-game is to move to a merchant market whereby there's a spot market for electricity and water. Ultimately they want companies at the end of current long term (take or pay) contracts to be able to compete in an open

market. That process has to happen gradually but I think it's what policy makers need to be thinking about now on the utility side.

**DAVID KEAT:** To a certain degree, the supply side drives its own efficiencies. I think there's a huge opportunity on the demand side, the usage by the public. If you look around the world, governments don't do a very good job of educating the public about what's required. Journalists often take a good cop/bad cop perspective on the environment and energy efficiency. Governments in particular can do more in terms of educating children and schools about energy and energy efficiency.

**JOHN WISHART:** Reducing demand is the best form of efficiency. It is easy to say but we have to take a longer term view. If you look in societies where people pay more for their electricity, it's been a bigger driver of efficiency. It then puts thresholds onto how you build homes. That brings down the demand curve, which then impacts the levels we need to produce that. And all of that is interlinked.

**DAVID KEAT:** The demand side is complicated – it's to do with human behavior. In many countries now the building codes have gone from absolutely nothing to considerable. That's a clear step change driving legislation which will deliver significant reduction in energy demand. Now if I choose to leave my door open all summer long, that's a behavioral thing. But if my house is built well I'll use less energy anyway.

**MG:** Omar from your experience. How can producers adopt more efficient measures on a broader scale, do you think?

**OMAR MOHAMMED:** In our company we have system solutions from the perspective of reservoirs. We make complete studies and will be able to tell you what is at 15,000 feet or 30,000 feet and based on the results whether or not such a reservoir is economic or uneconomic for production. This is detailed information enhanced by the latest technology and ultimately it provides solutions.

**JOHN WISHART:** The other key area is the use of sensors. More sensors provide you with

*"If we don't burn that feed stock, we can sell it as a product. So there's usually a strong business case for energy efficiency and that drives year-on-year improvements."*

**DAVID KEAT**



*"We all have to learn to be smarter in how we use energy. It's going to take a generation but you start with children, they learn pretty quickly, they learn to respect and to turn power off, turn power down."*

**JOHN WISHART**

the ability to see more of what's happened so you can track leaks or inefficiencies. We can see at a glance whether plants are running at optimum conditions. So I think that's again where technology can enhance and provide early indications for change or repairs.

**MG:** We have a question from the audience?

**UNKNOWN MALE AUDIENCE MEMBER:** From the producers' side now oil prices are going down, will it encourage them to become more innovative to preserve energy?

**DAVID KEAT:** That will happen naturally, particularly in the UAE. Here we produce a lot of water with distillation which is incredibly energy intensive. There are other filtration technologies which would conserve some of that energy. And that's a fertile area for research and development in future. Producers are acutely aware of their business economics and will already be putting in energy efficiency enhancements.

**JOHN WISHART:** There's a societal responsibility we have. As the oil price falls and energy prices comes down, there's a danger we feel we can keep on using energy freely. You have to take the opportunity that as oil price comes down you maintain energy prices, and then look at how to work the demand side to be more efficient. Producers can introduce a lot more technology

to be more efficient. But we as users have to be smarter.

**ADRIAN CREED:** I heard about one good initiative where Abu Dhabi invited a number of the top desalination companies in the world to come and build small pilot desalination plants, to test new renewable energy technology here. If governments help by providing some land, there could be some real benefits coming out both for companies and for countries like the UAE which really needs an efficient water sector. The program aims to bridge the gap between promising new technologies and large-scale industrial applications powered by renewable energy.

**AUDIENCE MEMBER - SEAN EVERS, GULF INTELLIGENCE:** I wanted to ask David to comment on the subsidy to industry. The gas is heavily subsidized and is consequently being reinjected into the fields. How much does the subsidy to the gas price distort the ability to be efficient?

**DAVID KEAT:** ADNOC companies basically receive gas almost for free. If gas was more expensive, oil producers would look at alternatives and the ADNOC group is actively looking at CO2 and other gases. That would help drive projects to use fluids other than natural gas, which may be attractive in a climate change sense but may not

necessarily make a tangible difference in an energy consumption sense. Gas is used to produce oil and that's part of the UAEs long term strategy. By injecting gas it gets more oil. That's the revenue side of running the country. That's purely an economic conversation and it makes sense to give cheap gas to the oil producers. They get a big payback on that.

**SEAN EVERS:** I suppose that's true as long as you're not importing gas at \$16 or \$18 per BTU, which is on the horizon in the coming period when the LNG plant in Fujairah is opened. That would sort of distort the whole pricing architecture.

**DAVID KEAT:** At the moment we import gas from Qatar at an intermediate price. The reason a company like mine exists is to produce more gas internally that will at least temporarily shift the gas balance in a positive way. And there are other plants coming behind ours. At a certain point you run out, and that's where the import comes in.

**MG:** David your project is going to provide a lot of water by virtue of the processing of sour gas coming out of the Shah gas field. Clearly, this is a water stressed area. What kind of benefit can Abu Dhabi have from that?

**DAVID KEAT:** We're actually a frontier in the world since, we are the highest, about to be the highest hydrogen sulfide concentration gas field to be produced. One of the side effects is that the hydrogen sulfide ends up producing a lot of water as we process it. So we will actually produce a lot of water. The future undeveloped fields in the UAE are mostly sour as well. So it's a small but significant source of water going forward.

**JOHN WISHART:** Clearly technology is at the heart of innovation. We need to be looking at mechanisms that don't use water. We need other methods of stimulating fields. As we regenerate power from power stations, we can collect the CO<sub>2</sub> and can use that to reinject into fields. Again it's back to this holistic view.

**MG:** Adrian, how do you think Abu Dhabi, Dubai can improve their water management strategy?

**ADRIAN CREED:** One thing to look at is government procurement methodologies. Right across the region, there's a very strong drive towards greater transparency and bidding processes. Governments need to look at ways to encourage companies and creative thinkers to come up with solutions. For example, Jordan is trying to encourage renewable energy technologies. Instead of writing a detailed spec, the Ministry of Energy and Mineral Resources has opened up the Jordanian market to new innovative technology providers by introducing a "direct proposal" option whereby for projects of less than 500 MW, private sector developers would be able to submit their proposals without having to go through the normal Jordanian compulsory competitive tender process.

**MG:** We have a question in the front row.

**UNKNOWN MALE AUDIENCE MEMBER:** How attractive is it for the public to generate their own power at home. Do you think this might happen in this region soon?

**JOHN WISHART:** The incentive for that to work occurs when pricing levels are such that you can justify the use of the photovoltaic cells on roofs. In the UK it began because electricity prices are so high. I think there are elements and renewables that will work well in some places, not so well in others.

**ADRIAN CREED:** I think there's definitely a place even in hydrocarbon rich economies. The introduction of green building codes in the MENA region is pushing in the right direction. I think we're going to see some real changes here so I don't think it's a dream. It's going to happen. Another thing that GCC countries have been trying to do is to develop a feed in tariff so that small domestic electricity producers can sell their power back to the grid.

**MG:** We have a question from the lady in the second row.

**UNKNOWN FEMALE AUDIENCE MEMBER:** A couple of years back, I heard about a new

*"Right across the MENA region, historically utility bills have been very low and haven't reflected actual consumption. But now when you get your bill in Abu Dhabi, it will tell you what you've consumed and what your subsidy is."*

**ADRIAN CREED**

*"The key point is we need energy. Of 7 billion people, 1.3 billion don't have access to electricity and we must ensure that energy is affordable for everybody."*

**OMAR MOHAMMED**

technology which is going to be developed in UAE outlining generating energy from waste. Has it been implemented or soon you're going to implement?

**ADRIAN CREED:** Waste to energy should have moved further ahead in this region in my opinion and it hasn't. But most generating companies (including waste-to-energy companies) need to be licensed, because historically that has been an activity undertaken by the state, not by the private sector. So there's a regulatory aspect there. But it makes no sense to me that there's not more waste-to-energy projects in the GCC.

**DAVID KEAT:** In terms of waste recycling, it's clearly a good thing and we should do it but it's not going to close the energy balance. As John says, the answer lies in a holistic sense, lots of little things which add up to the whole.

**MG:** Another question in the front row.

**AUDIENCE MEMBER - HATEM SALEM, BAKER HUGHES:** Most likely we still haven't gotten the best out of the hydrocarbon for various reasons. So what is the level of focus on new discoveries vs. extracting more supply from current fields?

**DAVID KEAT:** Speaking on behalf of the whole oil industry (editor: joke), it is very driven by commercial and risk balancing. There's a huge amount of research and development on extracting more barrels from existing fields. That's balanced with looking for new fields altogether, or new producing areas.

**JOHN WISHART:** We recently ran some research and spoke to over 250 oil and gas executives and the top themes were on enhanced oil recovery, how the industry can produce more from existing reserves, improved drilling and imaging and how we can better extract. It goes to show that there is a lot of money being invested in these areas. Because we're able to do these long-distance, multiple fracked wells for example, goes to show that we've been investing in that technology over a significant period of time.


**OMAR MOHAMMED:** That's right. We have the technology for multilateral wells now and forward lateral. So you minimize the number of wells and you still produce oil or gas from patterned formations or shale or high pressure, high temperatures. And we can now also take samples during drilling to understand what's inside, gas or oil, during the drilling phase. So a lot of technology exists to improve and make it economic also.

**MG:** We have one final question.

**AUDIENCE MEMBER - UNKNOWN MALE:** You say it requires transformations, behavioral change in this region but what is required from the government to balance supply and demand?

**JOHN WISHART:** We all have to learn to be smarter in how we use energy. It's going to take a generation but you start with children, they learn pretty quickly, they learn to respect and to turn power off, turn power down. Adults are the hardest to teach. We stick to our old habits but we need to learn more. On top of that, the other thing that will drive it is governments. Next year in Paris, there'll be further talks on global warming and reductions in CO<sub>2</sub> levels which will really push the debate on energy usage. It's unrealistic just to say what should governments do, however government can help make us aware of the challenges we face.

**MG:** I'll leave the final word to our host David Keat of Al Hosn Gas.

**DAVID KEAT:** Governments can pass laws, they can set visions and they can conduct programs, the educational programs we talked about. In terms of vision, I think the UAE government is good. But the most important thing for me is what John was saying - educating ourselves as individuals and as a community. We have to educate our children to behave better than we have and there are many dimensions to that but energy efficiency and environment protection is key. 





# **Volume, Velocity & Variety: Data - a Key Resource for the 21st Century Oil Industry**

**By Abdulla Al-Qamzi, Manager Digital Oil Field, ADMA-OPCO**



**Hydrocarbons may sit** at the heart of the global oil and gas industry but over the past decade another resource has emerged as a critical asset for companies involved in the sector: data. Whether in the oil sector or elsewhere, greater volumes and varieties of data are sweeping into businesses and individuals lives at ever higher speeds, changing and digitizing the way we do things, and playing a key role in our strategic and tactical decisions.

Indeed, thanks to rapid advances in and the widespread adoption of information and communication technology on the one hand, and sensors, measurement instruments and observation equipment for gathering information on the other, the oil industry is being transformed at an unprecedented pace and scale. Today, oil companies are in a position to capture more detailed data than ever before at lower costs and from previously inaccessible areas, enabling them to improve and optimize oil field and plant performance, drive efficiency and enhance safety.

Already, oil fields are increasingly connected from end to end, enabling companies to harvest and analyze massive amounts of data generated by people and assets along the oil value chain in real time. As the oil industry seeks to access harder-to-reach reserves in increasingly remote and challenging environments, companies will be dealing with even more complex data in their operations in the future.

As the volume of data obtained from oil fields grows exponentially and continues to become more diverse, complex and frequent in occurrence, the correct and timely evaluation of this so-called 'big data' will play an ever-more important role in the industry's operations and decision-making processes going forward.

The reason is clear. Developing sound strategies to integrate and manage the increased data volumes and using it in smarter, faster ways can be a key differentiator for oil companies because it has the potential to boost their competitiveness. Processing data accurately also has a positive impact on project economics, and makes or breaks the successful application and operation of technologies such as enhanced oil recovery (EOR) in oil fields.

According to McKinsey & Co., generally, there are five ways in which big data can create value for companies. First, big data can unlock significant value by making information transparent and usable at much higher frequency. Second, as organizations create and store more transactional data in digital form, they can collect more accurate and detailed performance information on everything from



This is also relevant for companies operating in the oil sector. Digital Oil Field (DOF) technology for example, also known as Smart Field technology, which essentially enables big data analytics, helps companies in reservoir and production optimization, and drilling and well completion among other processes. The application of DOF also speeds up and allows more accurate analysis and decision making, and to manage assets more efficiently and safely.


Faced with the need to extract increasingly expensive hydrocarbon resources as the era of easy oil has come to an end, national oil companies (NOCs) in the Gulf region are recognizing the need to utilize big data to their advantage in order to maintain and enhance production levels. It is unsurprising then that—according to the latest numbers from market research firm RnR Market Research—the Middle East, together with the Asia-Pacific region, is going to be the world's fastest-growing DOF market over the next 10 years with a compound annual growth rate (CAGR) of about 7-9 percent through to 2019, and of 5-6 percent up to 2024 – largely driven by the benefits DOF technology provides in relation to operations and analysis.

At ADNOC and its operating companies such as ADMA-OPCO, the introduction and implementation of innovative solutions such as smart field technology has been integral to its long-term planning for some time. With the era of post-easy oil also under way in Abu Dhabi, technologies such as DOF have been introduced and will become even more important in the extraction process and—ultimately—in achieving the self-declared goal of reaching a recovery rate of 70 percent.

The emergence of big data and related technologies comes at a time when the global oil industry is faced with a considerable skills shortage that could worsen over the next 10 years as larger numbers of today's oil and gas experts and engineers are retiring.

For the industry it will therefore be critical to fill the widening gap with talent that has the right expertise to convert the enormous volumes of data being generated into useful knowledge.

Without a doubt this will be a challenge. But at the same time, it is an opportunity for today's young generation to approach the industry's challenges with its unique '21st-century' skill set and approach to problem solving and collaboration.

As data emerges as a critical resource in the oil industry, there can be little doubt that the era of the Data Scientist and Digital Engineer has arrived. 

product inventories to stock days, and therefore expose variability and boost performance. Third, big data allows ever-narrower segmentation of customers and therefore much more precisely tailored products or services. Fourth, sophisticated analytics can substantially improve decision-making. And finally, big data can be used to improve the development of the next generation of products and services.

*"The emergence of big data and related technologies comes at a time when the global oil industry is faced with a considerable skills shortage that could worsen over the next 10 years as larger numbers of today's oil and gas experts and engineers are retiring."*



## PANEL DISCUSSION: OIL 2.0: BIG DATA & DIGITAL OIL FIELDS

### PANELISTS:

- **Abdulla Al-Qamzi**, Manager Digital Oil Field, ADMA OPCO
- **James McCallum**, Chairman & CEO, LR Senergy
- **Yahya Mahmoud**, Director, Oil & Gas - Resources And Process Industries, Oil & Gas Industry Lead, MEA Oracle
- **Morgan Eldred**, Oil & Gas Research Director, Gartner
- **Moderator: Sean Evers**, Managing Partner, Gulf Intelligence

**SEAN EVERS(SE):** What is ADNOC currently doing in the area of big data and digital oil fields?

**ABDULLA AL-QAMZI:** ADNOC has been paramount in implementing innovative solutions, especially in recent years. The good thing about ADNOC's methodology is that it did not restrict each company with a specific way of implementing digital oil fields. It gave directives to implement new technologies and solutions to reach the ultimate objectives of digital oil field and then left it to each company to innovate. For instance, ADCO's methodology was to go for a depth-first approach. Let's implement a fully smart field and prove it there, and then propagate the lessons learned to the other fields. We in ADMA-OPCO took a different approach. We took a breadth-first approach. Let's take small steps forward across all our brown fields until we achieve the aspired capabilities of DOF. While with our new fields, they are digital oil fields ready by design.

**SE:** Why do you think it was a sensible choice to allow every operating company (Opco) to do their own strategy rather than uniform across Opco's?

**ABDULLA AL-QAMZI:** My point of view: it allows innovation. And ADNOC is a huge driver of innovation. If it tells you how to do it, it restricts you somehow. While when you have this different approach you start to learn from each other and share the knowledge and the experience across all companies. Also, it

encourages the solution providers to compete and innovate.

**SE:** James, how do you see big data changing? Is it as radical a transformational instrument already, or is it going to be?

**JAMES MCCALLUM:** I don't think it's radical at the present moment in time. I don't think the industry is at all geared up to receive or interpret or apply the sort of thinking and best practice that comes from what data is actually telling us. The industry remains a siloed industry by discipline. So, if you're in the world of subsurface petrophysics or reservoir engineering versus drilling, these individual disciplines remain siloed in how they access data, how they interpret it and how they use it to move towards achieving best practice.

**SE:** What do you think is the right strategy then if a company is looking to adopt a digital or a big data strategy?

**JAMES MCCALLUM:** For me it comes down to two very simple drivers. You start to look at every single aspect of your business as a business. So where you're actually for instance drilling a well, you sit and look at the drilling function as a business and you're looking to make sure that this business is achieving the most efficient ultimate result that it can. The second relevant thing is that you actually set up your organization and your framework for collaboration. If we stick in that drilling space,



you're not going to have the most successful business if you're not also using data to collaborate into the subsurface space, into the geomechanics space, etc.

**SE:** Morgan, where is Gartner's view currently on big data? Where is it going?

**MORGAN ELDRED:** First, let's get to the definition of big data. There's volume in the large size of upstream modeling data. Then there's also real-time operating data, and then we've got transactional data that's in IT systems. So there's great variety. And it has a lot of velocity as it's very quick as well, real-time data is quite quick.

**SE:** Should you aspire, with building big data, that it is real-time?

**MORGAN ELDRED:** When we're talking big data, that's the traditional definition that everyone takes, it's those three things (Volume, Variety & Velocity). In our industry we have that. Big data will be prevalent in our industry for exactly the reasons James just mentioned: very strong organizational silos. Because big data is about having all this data, it's a world where you're having data scientists; a world where the machine is starting to predict, based upon patterns and trends in patterns, aspects that, from humans, we would never be able to see. That's where we see big data. When we look at it from our industry perspective, for us to bring all our data together, you need information management, you need governance and from an organizational perspective we're just not ready yet.

**SE:** What's the consequence of not being ready yet and can we afford to go another five or 10 years not being ready with big data and not being ready to handle that scale of data?

**MORGAN ELDRED:** Oil prices are declining and a few days ago there was a report about a leading unconventional asset in the U.S. saying that "at \$40 a barrel, they would still make a 10% profit". If we look at the unconventional, they've grown to 5 million barrels a day of oil and this will go up. These companies are aggressive optimizers, they're using technology, and they're using data to make business decisions to improve performance. So there's more competition and more supply now than we ever had. So yes, I think that we need to start looking at it.

**YAHYA MAHMOUD:** From our point of view, we concur with the Gartner definition on what big data is for the industry. Variety is definitely there. Volume is definitely there because we're generating huge amounts of data and velocity, which is the speed at which this data is being generated. The organizational silos in most of the firms that are operating in this industry need to rationalize their processes. They need to rationalize their investments to be able to tap into potential opportunities that would convert into value. We see the potential decline

*"Data is really in itself a resource; an asset. But without the right expertise to convert this data into knowledge that the company can make use of, the data is going to sit there."*

**ABDULLA AL-QAMZI**

of oil prices definitely impacting investments, but also giving a lot of firms the opportunity to optimize on the bottom line because if you can't make more on the dollar on the top line, you're definitely going to be optimizing costs.

**SE:** One of the dominant narratives in the industry is currently the talent shortage we're facing in the next 10 years: 50 percent of petroleum engineers are going to be retired. Is there a role for big data and for the automation of the production process in filling that gap?

**MORGAN ELDRED:** I think what is going to happen with the shortage of skills is we're going to find ways to automate those skills. As humans we're very clever and I think we're going to find ways to automate that.

**ABDULLA AL-QAMZI:** On the talent issue, the youth joining companies today, they're already filled with an IT background that makes them capable to operate these technologies. We're going to take the experience of the old generation and probably automate them or make them more virtual, but at the same time I think we're going to see more of a catch-up effect, where the new generation may not need too much effort to be trained on new technology.

**YAHYA MAHMOUD:** There's also the potential for us to look at new domains. Data science, for example, is becoming a very hot domain. It is a very niche skill and when you look at the new generation of employees coming into the workforce, that skill is not something that we can easily tap into.

**SE:** Where do we find data scientists? There are very few university programs.

**YAHYA MAHMOUD:** In 2012, there were eight universities offering data science programs versus 52 universities in North America offering data science programs in 2014. And it's pretty standardized. From our point of view, as a technology company, we see this as an opportunity for a lot of industry players

to tap into new types of skills that can bring in interdisciplinary capabilities that did not exist 30, 40 years ago. With that dynamic workforce, you're tapping into mutual sets and new sciences that will enable you to do things in a more efficient way. Then tapping into the potential of leveraging digital, social and cloud technologies you bring in that niche subject matter expertise that companies such as Senergy are leveraging to solve very complicated problems that really require someone who's got that 40, 50 years of experience behind them.

**SE:** Where do you see the forward arc in terms of the data scientists and the role that they're going to play?

**JAMES MCCALLUM:** Thirty years ago, the person who would command the biggest day rates in the drilling environment was a directional driller. As the industry moved from vertical wells to highly deviated wells, the directional driller would be earning thousands of dollars a day. As those wells became ever more complex, the role of the drilling engineer took over from the directional driller. As the directional driller was replaced with technology and all of a sudden the computer was controlling the decisions, it was the drilling engineer who was interpreting that data and telling the rig floor what to do. The role of the data engineer, the data scientist, is the next evolution of that process, as they themselves are taking that data and converting it into the decision. The challenge, I think, is that we are historically an industry that embraces those kinds of change very slowly.

**SE:** Morgan started out by saying that one of the greatest challenges of adopting big data was the fact that the industry is so cloistered in its own vertical. What needs to happen for that to change?

**MORGAN ELDRED:** If you're working on high margins you may not have the need or the efficiency may not be driving you as much. If price becomes an issue, then optimization becomes very important to the way you work.

*"I don't think the industry is at all geared up to receive or interpret or apply the sort of thinking and best practice that comes from what data is actually telling us."*

**JAMES MCCALLUM**



To optimize and to start integrating all the planning that occurs in all the different silos, then it's about data-driven optimization. Data is what's going to take us to the next step.

**SE:** Is there an understanding within ADNOC that there's no way to get to 70 percent recovery rates without a full adoption of this set of skills and tools?

**ABDULLA AL-QAMZI:** We realize—and the oil and gas industry in the region realizes—that we will not be able to achieve the 70 percent recovery without taking the next step, which is to go for digital oil field. As we all know, the age of easy oil in the region has come to an end. Luckily, ADNOC companies have been taking steps in the last six to eight years towards digital oil field. And in our new fields, as I said, digital oil field has been implemented by design.

**AUDIENCE MEMBER - UNKNOWN MALE:** When we're talking about big data, smart fields

are just one contributor. When you look at traditional operations, the rate of enhancement on technology and equipment that is being used today is a major driver. It's not just the smart fields that are contributing to big data—it's traditional operations. Your core daily operations are contributing to data volume growth. Now one important syndrome that a lot of people might be very familiar with, which is commonly referred to in the industry as the "Google Syndrome", is when there's so much data available, let's just store it all and then we'll find somehow some tool to search it. But what a lot of people don't understand is that behind the scenes, companies that provide such capability, such as Google, invest huge amounts of money on running correlations, indexing, segmenting and categorizing this data, providing you the ability to go and tap into that.

**SE:** If the industry doesn't develop its own competency in this area, and the likes of Google or others do, what happens then? If we have to





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**MORGAN ELDRED**

go to Google for this competency in 10 years’ time, do they become a dominant player in the oil and gas industry because they know how to do this, and they know how to do it to a scale that gives them leverage over the upstream oil and gas companies?

**AUDIENCE MEMBER - UNKNOWN MALE:** As a technology vendor, we’ve definitely thought about it. We don’t think that’s a possibility. I mean, everything is possible, but the probability of that happening is very low. The reason is, the domain expertise in the industry is very sophisticated. So you need to really ramp up and acquire a lot of engineering knowledge on how certain pieces of equipment operate, how the subsurface works? What are the different parameters? How do you integrate sub-surface with surface? How do you look at production data and go back and adjust reservoir models? So there is a lot that goes on behind the scenes from an engineering perspective that is interdisciplinary in nature between physics, geology and mechanical engineering. There’s a

whole domain of science behind that.

**SE:** In the sense of what will partnerships look like in the future, will we see new configurations of partnerships?

**MORGAN ELDRED:** If you look at the example of Google, they bought Nest. We see Apple moving into the home automation space. These are organizations that are moving into the smart home, the connected home, and changing their business model. The one thing that’s a little bit different about our industry from those industries is we have to move to our resource. We can’t just set up a manufacturing plant and 3D print hydrocarbons. We actually have to go to the reservoirs. So that’s the only thing I would say that’s a little bit more challenging.

**SE:** We held a roundtable in which we were talking about crossover technologies. One of the participants was a senior surgeon from Houston and he was saying now when you go to a healthcare event similar to ADIPEC, the largest

*“We see the potential decline of oil prices definitely impacting investments, but also giving a lot of firms the opportunity to optimize on the bottom line because if you can’t make more on the dollar on the top line, you’re definitely going to be optimizing costs.”*

**YAHYA MAHMOUD**

stands are not the previous main players, but they’re actually the data scientist companies, the data management companies, who are putting themselves out as major partners to the industry. What’s your view or vision for that?

**MORGAN ELDRED:** I absolutely agree. If we just look around all the companies here, how many of these companies are selling equipment, but also data-intensive oil field services? If we’d been here three years ago, probably the number would’ve been ‘X’ and if we see it today it’s exponentially higher. For example if you sell one piece of equipment for a one off price of \$50 and are able to provide a managed service of the equipment through data, you can then charge \$70 per year. There is a business model and it’s impacting the whole ecosystem.

**ABDULLA AL-QAMZI:** Data is really in itself a resource; an asset. But without the right expertise to convert this data into knowledge that the company can make use of, the data is going to sit there. So yes, we’re collecting a large amount of data, but we have to structure it in the right manner so that we have descriptive big data. Just to touch on this. There are three types of big data analytics: descriptive, predictive and prescriptive. These are the three layers of big data. Descriptive is when we collect the data and put it together in a structured format that is searchable and helps us know the “What has happened?”. When we identify the patterns, we start to understand what the predictions are that we can take from this or “What could happen?”. So it takes us to the next level, which is the predictive model. After that we have the prescriptive. Based on the predictions, “What should we do?” This is a step towards AI or artificial intelligence.

**SE:** But you’re dismissing the idea that you may have significant partners from that sector?

**ABDULLA AL-QAMZI:** No, that is a huge possibility. If we took the concept of digital oil field to the 1980s or 1990s and we had wanted to create digital oil field, what would it be? It would be an email being sent from the

platform to headquarters. Now the concept is totally different. I have to fit my wells and well head-towers, with smart instruments, control systems, and then I have to have the right power and the right communication channel and bring it to the super complex, then send the data to headquarters to a database where I can query it and have information out of it, in a collaborative work environment. So the concept is totally different from 10 and 20 years ago.

**SE:** How important in the evolution of this is cyber security?

**MORGAN ELDRED:** I think cyber security needs to be designed from the bottom up, first off, because if everything becomes connected it’s at risk so we need to take care of that. If we look at the equipment, a drilling rig, it’s quite a dangerous machine if you do something wrong with it. So there needs to be control of that, from the cyber-attacks and viruses that may occur.

**SE:** Is cyber security being adequately adopted?

**MORGAN ELDRED:** I believe it’s not adequately covered. If you think that now we’ve got mobility and are able to remotely monitor and control facilities offshore – that’s kind of dangerous. So we’re probably not doing enough in that aspect.

**ABDULLA AL-QAMZI:** Cyber security is one of the main components of digital oil field. Sometimes it’s overlooked as if it’s just a password or it’s just an access control. This isn’t the case. Cyber security should be there by design. In the case of our fields, brown fields, we have control systems that have been implemented in the last century, and the cyber security wasn’t a risk. We used to care about availability and integrity of the data, not the confidentiality or the security. In the UAE, the government has established the National Electronic Security Authority—NESA—and as a national oil company, ADNOC benefits from that. The importance of cyber security has been recognized and the government made sure that an authority is going to take care of it. [5](#)



# Unconventional Hydrocarbons: An Opportunity for the UAE

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By ADCO

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**Much has been** said and written about the rise of unconventional hydrocarbons, or difficult oil and gas as I like to call it, even more so in light of the latest 30 percent crude price slump. Unlike production from most of the producing fields in the Middle East, the extraction of shale oil and gas tends to be expensive, which means oil price drops to the tune we have witnessed over the past six months become a serious burden on operators in North America, in particular smaller ones with high debt levels who suffer first when margins shrink and profitability drops.

So far, and like in the past, the industry has shown that it can adapt to abrupt changes in market conditions. There are few, if any signs, that US producers are reining in output at present price levels, indicating that ongoing advances in technology are helping drive down break-even points already. With this in mind and technology constantly evolving further, it is fair to assume that the production of shale oil and gas is here to stay for some time.

For hydrocarbon producers and exporters such as the UAE the emergence of new supply sources isn't an entirely new situation. When UK oil production first started in 1975, the UAE had to adapt to the fact that a new competitor was coming to the market, adding new supplies and vying for customers. Numerous other producers have entered the scene since and markets have adjusted as they moved to meet a spurt in global energy demand growth, in particular in Asian countries led by China.

With the world's primary energy demand expected to remain on an upward curve and seen rising 37 per cent by 2040, driven by demand in Asia, Africa, the Middle East and Latin America according to the International Energy Agency (IEA), it is clear that more hydrocarbon supplies will be needed and global production capacity will have to be ramped up if the world's thirst for energy is to be met in the long term.

Against this backdrop, the emergence of technologies that enable the extraction of unconventional hydrocarbon resources in an economically feasible manner—and the arrival of new supplies on the market—is not so much a challenge for producers such as the UAE but rather an opportunity. Of course, the cost to produce a unit of oil or gas in the UAE remains among the lowest in the world. But as the era of easy oil is coming to an end also in this country, there will be a gradual shift towards applying new technologies to extract more hydrocarbons from existing fields on the one hand and to allow for the development of harder-to-access, unconventional reserves on the other.



The Bab and Shah sour gas fields are good examples of technically more complex projects that are being developed as necessity has arisen and economics have become favorable. But while ADNOC has already identified unconventional resources that could potentially be developed, these resources won't be tapped as long as there is no actual need to proceed with their development. Once the time comes and all assessments have been made, however, the UAE will be in a position

*“Being able to produce hydrocarbons at a relatively low cost, the UAE remains better placed than most to continue investing, producing and exporting, including to the US.”*

to utilize technologies such as horizontal drilling, hydraulic fracturing and others for its own purposes.

Having the advantage of being able to wait with their application has two obvious benefits for ADNOC: as technology continues to evolve, its cost is likely to decline in the future; and expertise and know how in applying unconventional technologies will improve further. This is where the opportunity lies for producers such as the UAE.

In the meantime—lower oil prices or not—existing plans and projects at ADNOC and operating companies such as ADCO will proceed undeterred. To be sure, the UAE, like other producers, has benefited from oil price levels of \$100 a barrel but the latest price slump still ensures healthy income for the country. Being able to produce hydrocarbons at a relatively low

cost, the UAE remains better placed than most to continue investing, producing and exporting, including to the US. For there is no doubt that, if the marginal price of oil drops, the cheapest oil will be from the UAE and other Middle East producers – and there will be markets for it.

In addition, the UAE—just as its neighbors in the Gulf—is faced with considerable domestic energy demand growth due to its expanding economy and growing population. This means production capacity will have to be expanded in order to avoid domestic consumption eating into exports or vice versa.

In the longer term, unconventional technologies are therefore likely to help ensuring that the UAE will continue to meet its export commitments while also being able to supply the local market. In conclusion, by and large, unconventional are an opportunity for the UAE. [5](#)



# PANEL DISCUSSION: THE RISE OF SHALE – GIFT OR THREAT?

## PANELISTS:

- **Mohamed Juma**, SVP, ADCO
- **Andrew Vaughan**, Vice President & Chairman, Shell Abu Dhabi
- **John Roper**, Head of Middle East, E.ON Global Commodities
- **Dr. Uwe Salge**, General Manager, Wintershall Middle East
- **Moderator: Sean Evers**, Managing Partner, Gulf Intelligence

**SEAN EVERS (SE):** I'd like to begin our discussion by inviting our panel host, Mr. Juma, to make some opening comments and to tackle the question of the session.

**MOHAMMED JUMA:** I would like to answer the question – gift or threat? We see it as an opportunity with challenges. I think any opportunity will have some downside and we have to manage it. The downside of course is that oil and gas prices are going down. However, we have experienced this in the past when the UK started producing oil. We found new competitors were coming to the market. So we see nothing different than what we have experienced in the past. Definitely, when you explore something new, welcome new technology, new know-how and new opportunities, accommodating these new technologies would help us. I don't think there is a distinction between conventional and nonconventional oil. It consists of difficult oil and easy oil as I would call it. Unconventional is oil for which we don't have the technology and know-how to produce it economically. But as market value and demand goes up, you'll find people who will tackle and tap these reserves, whether they are oil or gas. Abu Dhabi sees it as an opportunity. We have marginal fields that are difficult to produce and we take advantage of technology and know-how to produce difficult layers. Moreover, I would assure you that we also have unconventional, which we call "source rock".

**SE:** If we see the rise of unconventional to the scale that we've seen in America, is that a good thing for a major oil producer?



**SE:** Uwe, how do you see this question, gift or threat?

**DR. UWE SALGE:** First of all, I think that these two words, "gift" on one side and "threat" on the other cover a too wide range for unconventional. When you look, for example, to the U.S. where certainly there is a homeland of this new dimension in the oil industry then you have to see it's not a "gift story" – it's more a story of entrepreneurship, innovation and technology. It is a very good example for the fact that this indeed is needed elsewhere in the world. It's not a copy and paste exercise to bring the American story to other areas in the world. In other areas of the world, different circumstances and contexts apply, but they need the same kind of spirit.

Germany has unconventional, but we still have a way to go to convince the country to go this technology way. As a country, we think it is a very important to make in order to not lose a competitive edge here.

**SE:** Andrew, in terms of the unconventional revolution, is it a good thing or a bad thing?

**ANDREW VAUGHAN:** What we are going to see is a rebalancing because the market will ultimately take over. If you look at gas in the U.S., we're predicting that you will see production growth of about 1.6 percent per annum and consumption growth of about 0.8 percent. So there's going to be a surplus by 2040 and we see the U.S. exporting anything up to 16 billion cubic feet (BCF) per day of gas, which is 120 million tons of LNG a year. Put that in the context of a current market of 250 million tons a year and that's going to be significant. But is that going to mean a significant drop in the gas price? Probably not, because by the time you've taken Henry Hub, added liquefaction cost, added transportation cost, you're delivering it to market at about \$10-12 per million BTU. So a little bit of softening of the price, certainly a rebalancing of supply and demand in the market place, but we've got to look at increasing supply in the context of gas demand which is going to double in the next four decades.

**MOHAMMED JUMA:** It is an inconvenience because something you were selling for \$100 you are selling for \$80 and below today. So what I'm saying is, we will never go out of business; we'll be there all the time and the last drop of the world oil comes from Abu Dhabi. Therefore we are committed to continue exploring, developing and producing oil and gas in the most efficient manner with full adherence to highest standard of HSE (Health Safety Environment) and deployment of the best technique/technology.

If the oil price goes too low, it will affect unconventional because they are producing very expensive oil and gas, and cannot tolerate low prices. I think, very low income will jeopardize the unconventional projects/activities. We really encourage a fair price of oil and gas, which is win-win situation for everyone. We don't want the world to suffer: if the oil price and the gas price are too high, the manufacturing industry and consumer will be affected negatively. So we always go for the fair one. That's why I think when our countries (OPEC) saw the oil price going up very high in some cases; they acted positively to stabilize oil price at a reasonable level.



*"We are preparing ourselves for the unconventional, but we don't want to jump into it today. Technology is evolving, it becomes even cheaper. So why should we embark on something which today is expensive?"*

**MOHAMMED JUMA**



**SE:** Depletion rates on wells in shale are somewhere around 30 percent, is it dependable? Are you going to sign a 20-year LNG contract with a shale field in North Dakota?

**ANDREW VAUGHAN:** I think that depends entirely upon the resource. As we get more experience of dealing with that resource, we'll be able to start putting longer-term contracts in place. But I also think that the contracts are going to shift in balance; we're going to see consumers trying to lock and lower prices rather than suppliers lock and higher prices. So the balance is going to shift, but it will be a market-driven shift and I don't see it as a threat. In a world which is seeing increasing growth of demand, I see this as an opportunity rather than a threat.

**SE:** We're having this conversation with oil prices having corrected \$30, a German investment bank has reported that 40% of all shale projects in North America would be uneconomical and unviable at this price point – what's your outlook?

**JOHN ROPER:** I think there's no doubt that as oil prices drop there are going to be stresses on the developers, producers who have operations in both unconventional gas and unconventional oil production. I think it really depends on which operators you're actually talking about. It's not going to be the same across the board for all operators. In conversations that we've had recently, where we've been specifically trying to get ideas of what impacts would be, there are some out there that would say that their operations are fine down to \$50 or \$60. And they'll continue to apply the same amount of resource and intensity that they do now.

**SE:** In terms of the issue of threat to this region, if we see a continuation of the scale of development and success that the U.S. has had in the wider world such as China, is that not threat to MENA producers of energy?

**JOHN ROPER:** The markets are going to balance themselves in a way that's appropriate for both producers and suppliers. If China has this enormous resource and it is able to bring it to market at an appropriate price for its domestic consumption, then of course China is not going to be importing volumes from the Middle East in the same way that they might do or currently have plans to do in the future. So, in that context, Middle East producers are going to have to look for a new market for their oil.

**SE:** On what do you, as a producer, base your planning given the level of unpredictability of unconventional development around the world? China is one of your biggest customers.

**MOHAMMED JUMA:** First of all, whatever is going on as of today it's not going to impact our plans. Our plans are going to proceed as they have been scheduled. Moreover, we see the variation/fluctuation in the price is way below cost of our developments. It will inconvenience us, as I told you—it's better for us to have \$100 oil than \$80—but even at the lower prices we'll be able to justify our projects. We have unconventional reservoirs and fields, but we don't want to tap them today and we are in the process of generating optimum development options.

**SE:** The UAE is looking at serious growth in oil demand for domestic consumption, something like 50 percent going out to 2030 and gas demand doubling to 2030. In terms of the lost opportunity of exporting oil, should you not be moving quicker to develop your unconventional gas in order to tackle and defeat the domestic demand so the oil is for export?

**MOHAMMED JUMA:** We are preparing ourselves for the unconventional, but we don't want to jump into it today. Technology is evolving, it becomes even cheaper. So why should we embark on something which today is expensive? It might be cheaper in future. We are not desperate to produce unconventional today, we have plenty of gas to meet our requirements. Sour gas developments have good productivity. The only thing that we have to deal with is the high sulfur content. We are talking to our partners who have done a good job in the past and continue to work with them to bring their technology and know-how. So we are not really working alone, we have leading technology partners with us.

*"We need now to be looking beyond the next 200 years where renewables, other new forms of technology, new energies will take place, not only because we will need that resource to replace the finite resource, which is oil and gas, but also because of the implications of climate change."*

**ANDREW VAUGHAN**



*"If China has this enormous resource and it is able to bring it to market at an appropriate price for its domestic consumption, then of course China is not going to be importing volumes from the Middle East in the same way that they might do or currently have plans to do in the future."*

**JOHN ROPER**

**SE:** IOCs were slow to come to the shale opportunity, the unconventional, at least in the context of the U.S. shale revolution. That's changed now. How do you see the dynamic going forward?

**ANDREW VAUGHAN:** I think we're seeing the way the market has always behaved. The entrepreneurs come in, new technologies arrive, there's a first mover, and IOCs follow. We actually bit off a little more than we can chew in the States, to be frank, and we rebalanced our portfolio. And I think that's going to apply across the world. As the technology matures, it will become mainstream and then something new will come. So I think we're just seeing the oil industry do what it's very good at: bringing new technologies to play, applying them with the entrepreneur, but also ultimately the big guys, and then moving them on to maturing them.

**SE:** How will the recent correction in oil price affect your judgment in that respect?

**DR. UWE SALGE:** Indeed, the oil price has dropped significantly, but I think we should not make the mistake to see this already as a trend, because the fundamentals of the oil price development are still in principle to a

large extent unchanged. But we have to be very careful, the industry as a whole, not to jeopardize our investment schemes into the future. Because we also have the duty of meeting growing demand in the world and the recent outlooks from the international energy agencies see an increase of demand until 2030 by 30 percent. On the other side, we have a decrease of the oil price of around 30 percent at the moment. When you put this into a kind of equilibrium, then the low oil price surely is not really a trend. Within our industry we have to focus on our long-term investments to be successful.

**JOHN ROPER:** I think what it will do very quickly is focus those operators in the areas of their fields that are clearly better productive environments with wells that have higher production rates and slower depletion rates. And that will happen very quickly for the small companies. Andrew picked up on the point that the larger companies have come into this space. They're going to have a very different perspective on the total field development as opposed to the short-term development that the smaller companies will have. I think the immediate effect will also be that it will turn up people's interest on just how to apply technologies more efficiently.



**SE:** In the context of the UAE and the region, the pricing of gas in the domestic market, there's been a lot of talk in the region and here about the need to correct the subsidy structure and the price of gas. How does that affect the considerations for moving further into this development?

**MOHAMMED JUMA:** If you look at where we're using our gas, some of it is being exported as LNG, some is being consumed locally, and some is being injected back to maintain reservoir pressure for condensate and oil recovery. We have long-term plans. We brought Dolphin gas because it was convenient and appropriate to import rather than to develop. As time goes on, the economical values changes, new technology comes, it will be feasible to tap the more difficult one. I don't think they are unconventional today but still more expensive than what we already have. Our gas development schemes are optimized and robust with a proven portfolio of hydrocarbons in-place and reserves that will allow us to meet our current and future needs.

**SE:** The production of shale requires a tremendous amount of water. We're in a region in which water is scarce. How will these different factors obstruct the progression towards a MENA shale revolution?

**ANDREW VAUGHAN:** Again, I come back to the market. There will be costs going into the production of unconventional gas in the future, so that will factor into the decision that is taken

by the government at that time to produce and develop that gas. There's no question, the price of domestic gas will rise here as demand grows and production falls. So there will be pressure on prices. Some countries become dependent upon imports. We're already seeing LNG imports into a number of countries around the Gulf. So inevitably that's going to have an impact on price. Water, yes, would be a significant factor. But bear in mind that an awful lot of the oil production here is going to come with increasing amounts of water production. Is there an opportunity there to dispose of produced water in producing unconventional gas?

**SE:** Is there?

**ANDREW VAUGHAN:** I think there probably is. That's a technology that we should be looking at in the future. But the market will drive it ultimately, and I think that's what we just have to keep bearing mind. Ultimately, the market will come into play. You can only survive in a subsidized world for so long and then something starts to bend, or something starts to break. And already we're hearing talk from a number of senior ministers in the region about the need to remove subsidy, to get the market functioning effectively so that for example efficiencies can be brought into play. The UAE consumes three times the energy per capita as the OECD for example. Minister Mansoori is on record as having to say that's got to change. He calls energy efficiency the new fuel. So again, the market will play out here, I'm absolutely certain.



*"Indeed, the oil price has dropped significantly, but I think we should not make the mistake at this point that we see this already as a trend, because the fundamentals of the oil price development are still, in principle, to a large extent unchanged."*

**DR. UWE SALGE**

**AUDIENCE MEMBER:** Within the last 10 years, we've seen a lot of development of unconventional, mostly from North America. But if you go globally, it's still only a little bit from China. My question is: what's a good driver? Is it going to be technology, economy or geopolitics?

**DR. UWE SALGE:** Actually, the subsurface context is most important. If you want to produce shale gas or shale oil, you need a certain rock formation in a certain depth of certain perimeters. And this is not as widespread as some publications see it at the moment in this world. So subsurface is very important. And of course other details, like closeness to market, infrastructure, water supply and things like that.

**ANDREW VAUGHAN:** One thing we have to remember is that the U.S. has a very liberal market and a very light regulatory framework. That has really encouraged the boom we've seen. Other parts of the world we see outright ban fracking. We see very strong regulations. I think it really depends to a large extent on the market and the regulatory framework that you see locally, and the U.S. is almost unique in respect of having very liberal sets of both.

**AUDIENCE MEMBER - UNKNOWN FEMALE:** Because oil may not be replaced in energy production, maybe in 50 or 100 years it will be finished. What's our current version or plan for the future?

**MOHAMMED JUMA:** From an Abu Dhabi view it's very obvious: we are building Masdar and we're spending huge amounts of money on it to look into renewable energy, mainly solar and wind energy. We'd like to make sure that we will have energy in the future for our grandchildren. We are not short on oil and gas today. But of course, down the road, thing will be different. Hopefully, renewable energy becomes cheap enough so that we'll be able to utilize it in the future.

**ANDREW VAUGHAN:** Can I just talk to that point? There was a famous book written in 1973 called "Limits to Growth," and in that book there was a forecast that oil will run out in 40 years. Well, here we are 41 years on and we now have enough oil for the next 53 years, at the rate of current consumption. We have enough gas for the next 200-plus years. We actually get very good at developing ways to produce more oil and gas. But it is a finite resource; you're absolutely right. So we need now to be looking beyond for the next 200 years where renewables, other new forms of technology, new energies will take place, not only because we will need that resource to replace the finite resource which is oil and gas, but also because of the implications of climate change. So as we move from oil to gas which is a far more effective energy generator, with a far lower carbon footprint, the next step then will be renewables. [5](#)



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