The Shell ADIPEC 2013 & WFES 2014 Knowledge Series

Shell, Industry Experts Discuss Critical Topics at ADIPEC 2013, WFES 2014

THE PERENNIAL ADIPEC and WFES exhibitions are always among the UAE's most anticipated energy events – and rightly so. ADIPEC 2013 and WFES 2014, held in November and January respectively, once again drew large numbers of energy experts and provided valuable platforms to debate the latest trends and challenges the industry is faced with in a constantly evolving world.

The challenge of developing sour gas fields, field optimization through enhanced oil recovery, developing drilling expertise, and incentivizing tomorrow's generation into science – the themes covered at the Shell ADIPEC 2013 Knowledge Series were equally as broad as they were critical to the future of the oil and gas sector.

Bringing together leading industry experts and Shell executives at the Shell ADIPEC stand, the Knowledge Series—organized in association with Gulf Intelligence between November 10 and 13—took place against the backdrop of transformative developments unfolding in the global energy industry.

There was a sense of agreement from the debates that the industry will have to enter a phase of deeper collaboration – whether between IOCs and NOCs, governments and industry, or industry and academia – in order to ensure that it is prepared to take on challenges in the form of meeting rising world energy demand, advancing technologies, and attracting new talent into the industry.

The importance of collaboration across and beyond industries was also highlighted at the World Future Energy Summit (WFES) from January 20-22, where experts from around the globe gathered to address vital themes and trends surrounding sustainability in the energy sector.

Once again, top energy officials, industry executives and representatives from academia and multi-lateral organizations joined the Shell WFES Knowledge Series to discuss pressing energy challenges. This year's debate, held in partnership with Gulf Intelligence, focused on the inter-connectedness between water, energy and food, which—as a result of the world's growing natural resource scarcity—has become more apparent in recent years.

The key take away from the debates was that there needs to be a much harder push for enhanced, cross-sector and cross-industry collaboration and action among all stakeholders—governments, industry, academia, multilateral institutions and civil society—if the so-called stress nexus is to be resolved.

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Produced by Gulf Intelligence on behalf of SHELL

Business as Usual? The Challenge of Developing Sour Gas Fields

By Cor Verlaan, Manager Growth Engineering, Global Solutions Upstream, Upstream Development EMEA, Shell

Sour gas requires special handling and infrastructure because it contains significant amounts of hydrogen sulphide (H2S), making it highly corrosive, flammable and explosive, and therefore more costly and dangerous to process – but over the past decade sour-gas projects have slowly migrated into the business-as-usual bucket for major international energy companies (IOCs) that have the competence and technology to handle such developments.

Technological advances, rapidly rising global energy demand and strong oil prices have led to much-improved economics for sour-gas projects in recent years, which is timely with 40% of the world's untapped natural gas reserves estimated to be sour. The global demand for the previously unviable resource is set to grow by almost 60% between 2010 and 2040, which is sure to trigger a quantum leap in the number of sour gas projects under development.

Most of the world's largest sour-gas fields are located in the Middle East, with development of these resources already launched in Oman, Kuwait, Saudi Arabia and in the UAE, while other countries in the region are mulling similar options amid soaring domestic energy demand driven by gas-fired power stations, desalination plants and industries such as petrochemicals.

In the UAE, Abu Dhabi is home to two of the world's biggest sour-gas projects—Shah and Bab—with the latter recently awarded to Shell in partnership with Abu Dhabi National Oil Company (Adnoc). The project is set to produce 500 million standard cubic feet of much-needed gas by 2020 for the domestic market, which has already seen demand surpass supply.

To be sure, while sour-gas-field developments have become more mainstream across the industry, they still provide companies with a multitude of challenges. The dangers involved in these projects, both for people and environment, mean that safety management systems and risk mitigation have to be at the core of any such project.

Fundamental knowledge and rigorous application of Health, Environmental and Safety (HSE) policies are essential.

The quality of people, products and facilities sourced and built has to meet the highest industry standards at all times, which may require elevating the qualifications of those tasked with such enormous responsibilities. This is of particular importance in a location such as Abu Dhabi, where—like in other Gulf States—companies are confronted with a hostile natural environment due to the harsh desert heat conditions.

The economics of these developments are very much determined by the price of natural gas, but the price of sulfur too is a key factor when determining a project's economic feasibility. The demand for sulfur is on the rise globally and once stripped out of the sour gas the once-poisonous material provides an opportunity for companies to extract additional value from the project. Canada, holder of significant sour-gas reserves, today is the third-largest producer of elemental sulfur and the world's top exporter of the material.

Sulfur is being used in the production of sulfuric acid for phosphate fertilizers, and in various industrial applications such as metals leaching for copper, zinc and nickel. While the bulk of sulfur from Abu Dhabi's sour-gas fields is earmarked for export with a massive rail project underway to carry the material from the remote desert field to the Gulf port, Shell is exploring plans to use some of the material produced from the Bab sour-gas field to build a domestic downstream industry in the production of fertilizer, paving asphalt and concrete, thus adding value locally.

Given the complexities it is crucial for operators to continue improving the economics of sour-gas projects in the short term by applying new technologies such as bulk separation or improved solvent processes amongst others, and —over the longer term— continue investing in research and development to come up with transformative technologies to extract maximum value from this hydrocarbon.

While the cost-effectiveness of technological solutions is a crucial factor for the economics of sour gas development, other factors come into play too – there is a general shortage of experienced engineers in the industry and consequently they have become a rare and highly-priced commodity over the past decade. It is critical to have qualified and experienced engineers on board to deliver these complicated and potentially dangerous projects, but equally as important is to have a squadron of young engineers engaged to absorb this unique experience for the decades to come.

Taking all these factors into consideration, it is clear that they have a major impact on a project's economics and development costs, which tend to be well above those on conventional gas-field developments. But overall, while the economics of sour-gas projects have become more favorable for companies developing the asset, it is crucial for resource-owners to price gas for domestic market at prices closer to the global market level.

For countries such as the UAE with a fast growing appetite for gas, there is another rationale to tapping into its sour-gas reserves. Projects such as Bab and Shah are integral to the country's economic diversification strategy, which to a large extent is based on the availability of natural gas as feedstock in power generation and industries. Ensuring sufficient gas supplies in coming years has therefore made the development of these fields—like the import of liquefied natural gas (LNG)—a necessity rather than a development of choice.

Given the improved economics of sour-gas projects and the ongoing technological advances, combined with rising gas demand, the sour-gas story in the region has only just begun.

"The quality of people, products and facilities sourced and built has to meet the highest industry standards at all times, which may require elevating the qualifications of those tasked with such enormous responsibilities. This is of particular importance in a location such as Abu Dhabi, where—like in other Gulf States—companies are confronted with a hostile natural environment due to the harsh desert heat conditions."

BUSINESS AS USUAL? THE CHALLENGE OF DEVELOPING SOUR GAS

HOST: COR VERLAAN - Manager, Manager Growth Engineering, Global Solutions Upstream, Upstream Development EMEA, Shell
DR. MOHAMED SASSI - Professor, Mechanical Engineering, Masdar Institute of Science and Technology
DR. TONY ADDIS - Technical Director, Unconventional Resources Eastern Hemisphere, Baker Hughes
PATRICIO RIVERA - Vice President of HSE, Al Hosn Gas
MODERATOR: DYALA SABBAGH - Partner, Gulf Intelligence

DYALA SABBAGH Cor - is it economically viable to invest in sour gas projects?

COR VERLAAN As well as looking at cost, we have to see what the values of the products we can get out of it are. If you look at the recent sour gas projects in the area, where the amount of sulfur is significant, the price of sulfur is one of the income streams.

DYALA SABBAGH Would sour gas projects be viable without having sulfur as a byproduct for export?

COR VERLAAN That depends on the ultimate gas price and on location. If you're sitting in the U.S., you could most likely buy gas for $1 or $2 per million BTUs. But in Japan, they have to buy gas for about $15. So it all depends on what resources you have, how easy is it to develop and how it compares to other energy sources you're utilizing in the country.

DYALA SABBAGH Tony - on this question of financial feasibility, what would you say are the critical factors?

DR. TONY ADDIS We (Baker Hughes) are less sensitive to some of those economic drivers, particularly things like sulfur as a byproduct. But certainly what we've seen over the last 20 or 30 years is a significant variation in the price of sulfur going down from about $100 a ton to about $25—$20 in the period 2000-2003; at that point, some of these projects really didn't look as attractive as they are now. So certainly the service companies feel that effect when projects are either put on hold or whether they are advanced, because of the fear of economics. Fortunately, at the moment, good sulfur prices are supporting the project.

DYALA SABBAGH What about the dimension of risk—How should companies mitigate against this?

DR. TONY ADDIS The consequences of something going wrong in sour gas projects are quite severe because of the health and safety issues. There's also the impact of the sour gas, the H2S, on material or component failures. But it doesn't have to mean an increased risk overall, because all you have to do is focus on those elements of the project to reduce the probability of them happening. So I think rather than an increased risk, there's a different risk profile. And through good project management, you can still have a very safe operation; it's just that you have to look at some issues which are slightly different to a normal field.

DYALA SABBAGH In this region, do projects have the right management on the ground? Is the talent for mitigating that very high risk available?

DR. TONY ADDIS You have to focus on the entire spectrum of operations and properly train personnel. You have to have the right control systems in place, to monitor the systems, and mitigation plans, so that if something does go wrong at a certain level of the whole operation, you can respond to it quickly, and this all requires a very mature management.

DYALA SABBAGH Patricio, you're VP of HSE at Al Hosn Gas, which is managing the Shah sour gas project that's coming on stream next year. What's your perspective on risk mitigation?

PATRICIO RIVERA We have been talking about two of the main problems that the oil and gas industry is facing nowadays:

One is technology: several years ago, projects like the Al Hosn sour gas project were not technically feasible but now new technologies such as corrosive resistant alloys and other new materials have made them feasible. The other issue is managing risk.

The second one is attraction and retention of talent: during the construction phase of a "mega-project", we use up to 40,000 people before you even get to the production phase (gas). We certainly don't have that many people with experience in working in these types of projects.

In this regard, ADNOC has to develop younger engineers, that then have to be trained and hopefully capitalize on such training in the project. Even when that happens, you still have to look at the senior staff and seek for them not to retire so that they can pass that technology knowledge to the youngsters, as well as exercise mentoring and coaching.

DYALA SABBAGH What about the Emiratisation targets that are in place? Is that an added challenge to sourcing the right talent?

PATRICIO RIVERA The challenge of getting people is industry-wide; it's not just for sour gas. Companies like ADNOC have programs such as the CAMS which is the development of youngsters, and 'The Engineering Development Program'. So as you develop the project, you also have to develop people. And you have to invest the resources hoping that you will capitalize them in your project. There's also the other factor of strong competition for this talent.

DYALA SABBAGH Cor- could this talent challenge slow these projects down?

COR VERLAAN Yes - this is indeed a threat to the projects. There are two aspects: one is Emiratisation and having people able to operate these facilities, and the other is capable designers and dependable material suppliers - all are critical to success.

DYALA SABBAGH Dr. Mohamed - how critical

is academia's contribution in R&D to getting the technology and equipment aspect right?

DR. MOHAMED SASSI In academia, we look at things differently from project managers. We look for out of the box solutions. If we look at cost for example and volatility in sulfur prices, we would say, let's create more products out of this sour gas.

Some of the research we are doing at the Masdar Institute is a new process of thermal dissociation of H2S into hydrogen and sulfur; so producing two products. Hydrogen is very important nowadays, with the development of fuel cells and hydrogen-driven cars. The other area is CO2 capture in enhanced oil recovery which Masdar and Siemens are working on; if this for example could be integrated into the sour gas project, you could make more profit.

On the subject of talent, I would recommend to companies such as Shell or Al Hosn to integrate their specific programs within an academic curriculum. So you can have graduates across the scientific spectrum - not only petroleum engineers - brought up to speed with training to do the job. This would also help meet Emiratisation goals.

DYALA SABBAGH Patricio - talent aside, do you agree with Dr. Sassi's point that additional by-products and therefore other sources of income can be generated from the sour gas fields?

PATRICIO RIVERA Introducing a new process will demand what we know as "management of change," and that will not be practical at this particular stage of the project. We are always looking to add and use new technologies that make projects more profitable or economic and safer. The Al Hosn Gas project has been designed with the best systems available.

DYALA SABBAGH Tony - do you see a tendency for operating companies to go directly to service companies like Baker Hughes for their technical solutions, rather than go to academia?

DR. TONY ADDIS I think to some extent there is, because the service companies have a broad range of products and tools to apply to all applications in conventional and unconventional reservoirs. But it's a question of where the gaps are. And I think that's where the universities or the Masdar Institute can come in. One of those gaps is engineers with hands on experience working in these environments and universities can certainly supply the raw feed of the talent for these operations, and then companies like Shell and Baker Hughes can do the practical in the field training to support that. The Baker Hughes training center in Jebel Ali has about 400 people at any one time training up on all aspects of drilling and completions.

DYALA SABBAGH On whom does the onus lie to make this collaboration take place?

COR VERLAAN I think in principle it should be the companies, who want to build and operate something. They have to deliver a product in the end, so they have to ensure that they have the people, money, materials and technology to do it.

From the talent perspective, we start by utilizing people with sour gas experience in ADNOC, but we also utilize some of our employees working on our sour gas projects elsewhere, in Kashagan, Oman and Canada for example, who can come and work here directly in the project team and bring their experience.

PATRICIO RIVERA That is, in my view, the most important portion that the joint venture partners can bring to the table - the experience, and passing that experience onto the national employees.

Another major challenge for sour gas projects is the cost of services. For example, when it comes to drilling —we need a contractor to do that - and if we don't maintain good control of it, the cost could increase dramatically.

DR. TONY ADDIS Certainly on the service sector side, there's a continual pressure to reduce our costs, and we understand that. As soon as you go to unconventional resources, 80% of the cost is on the drilling and completion. There are a lot more wells for example in an unconventional shale gas play compared to conventional gas. We understand those pressures, and we push those margins down as much as we can. What we're trying to do now is become smarter. So we're saying, for example, give us all the services you need to get done (rather than split them between different providers) and we can reduce the overall cost while maintaining a margin. It's an extremely competitive environment and that's why service companies like Baker Hughes are looking at these different business models.

> *"The consequences of something going wrong in sour gas projects are quite severe because of the health and safety issues. There's also the impact of the sour gas, the H2S, on material or component failures. But it doesn't have to mean an increased risk overall, because all you have to do is focus on those elements of the project to reduce the probability of them happening."* **DR. TONY ADDIS**

DYALA SABBAGH Do you think this service cost is pushing NOCs or IOCs to invest in having their own in-house technical talent?

DR. TONY ADDIS Traditionally there's been a relationship between the IOCs, the supermajors, and the ISCs - the integrated service companies - to jointly develop technology and implement that technology in the field. What we've been seeing over the last 10 years is generally more focus on energy security, with NOCs not relying as much on the IOCs. And while there's still a relationship that's being built between the NOCs and the service companies to provide all the services - such as the hardware, the tools required - you also have the likes of Saudi Aramco which is opening research centers around the world - in locations like Houston, Aberdeen and The Hague. So they are stepping forward and not just being the recipient of technology. So yes there is a change.

DYALA SABBAGH Cor - do you agree that this shift happening?

COR VERLAAN Shell has always done a lot of research. We have a big lab in Amsterdam and a research centre in Houston and in Bangalore. So we try to develop things in-house, which reduce cost and increase efficiencies. But we still have to work with service companies because we don't have all the resources to do it all ourselves, and they are also going to do the implementation in the end anyway so it makes sense to include them in the solution.

DR. MOHAMED SASSI I think all of the parties - IOC's, NOC's, service companies - need to work together when it comes to research and development, with the help of academia, as we start creating new research results and developing new technologies. These things can be managed IPs that are contracts between all, to benefit all parties.

COR VERLAAN I think Mohamed is completely right. By working all together, you're also encouraging more people to enter this technical area, and get them interested, instead of going to banking or other professions. Showing what great things research can bring for the future is good for the growth of the technical population.

Field Optimization Through EOR: It's All About The Data

By Clement Edwards, WFRM Manager JV Excellence, PT Discipline Lead, Shell

Over the past decade, the global oil industry has undergone what may well be described as the most transformative period in its history to date.

Ongoing innovations in techniques such as enhanced oil recovery (EOR) have injected new life in many ageing oil fields and brought the development of many new ones into the realm of economic viability. Around the globe, the application of innovative EOR techniques such as gas injection, steam injection and polymer flooding in conventional oil fields are driving up recovery rates, including in the Middle East, where the era of cheap oil has come to an end.

With world energy demand forecast to double by 2050, developing these conventional resources will remain a top priority for energy companies in the foreseeable future – despite an abundance of unconventional reserves such as shale oil, which have increasingly become commercially feasible to develop.

At the same time, advances in information and communication technology are changing the way oil companies communicate, operate and process increasingly large amounts of data running into petabyte territory, or into the millions of gigabytes. From raw exploration data to real-time production data, refinery process-related data, and trading and retail data – few industries have to handle the breadth and volumes of information being generated in the oil sector today.

Managing and evaluating data has always played an important role in decision-making processes in the oil industry – and will do even more so going forward. As the energy industry seeks to access harder-to-reach reserves in ever-more remote and challenging environments, companies will be dealing with more complex data in their operations.

Developing sound strategies to integrate and manage data and using it in smarter, faster ways can be a key differentiator for energy companies, affect project economics, and make or break the successful application and operation of technologies such as EOR in oil fields.

The rationale for putting in place a comprehensive data strategy is therefore clear. Poor data management and difficulty accessing it means its value is bound to decline over time and the ability to make field-critical decisions will be affected negatively. Availability of and access to data containing potentially crucial information on the other hand is a precondition for the successful search and development of oil reserves. It also improves efficiencies and helps avoid duplication.

Gathering and managing data is one thing. Evaluating it another. As such, it is essential that experienced engineers, not IT specialists, take ownership of the data to verify its quality and ensure that it meets expectations and industry standards. After all, just as using poor data leads to poor decision making, the availability of quality data will ensure sound decision making.

Similarly, the visual presentation of the data in 'digestible form' is important so that petroleum engineers are in a better position to analyze and respond. Simple decisions should be automated and harder ones guided. This is of particular importance in an industry where swift decision making is often critical.

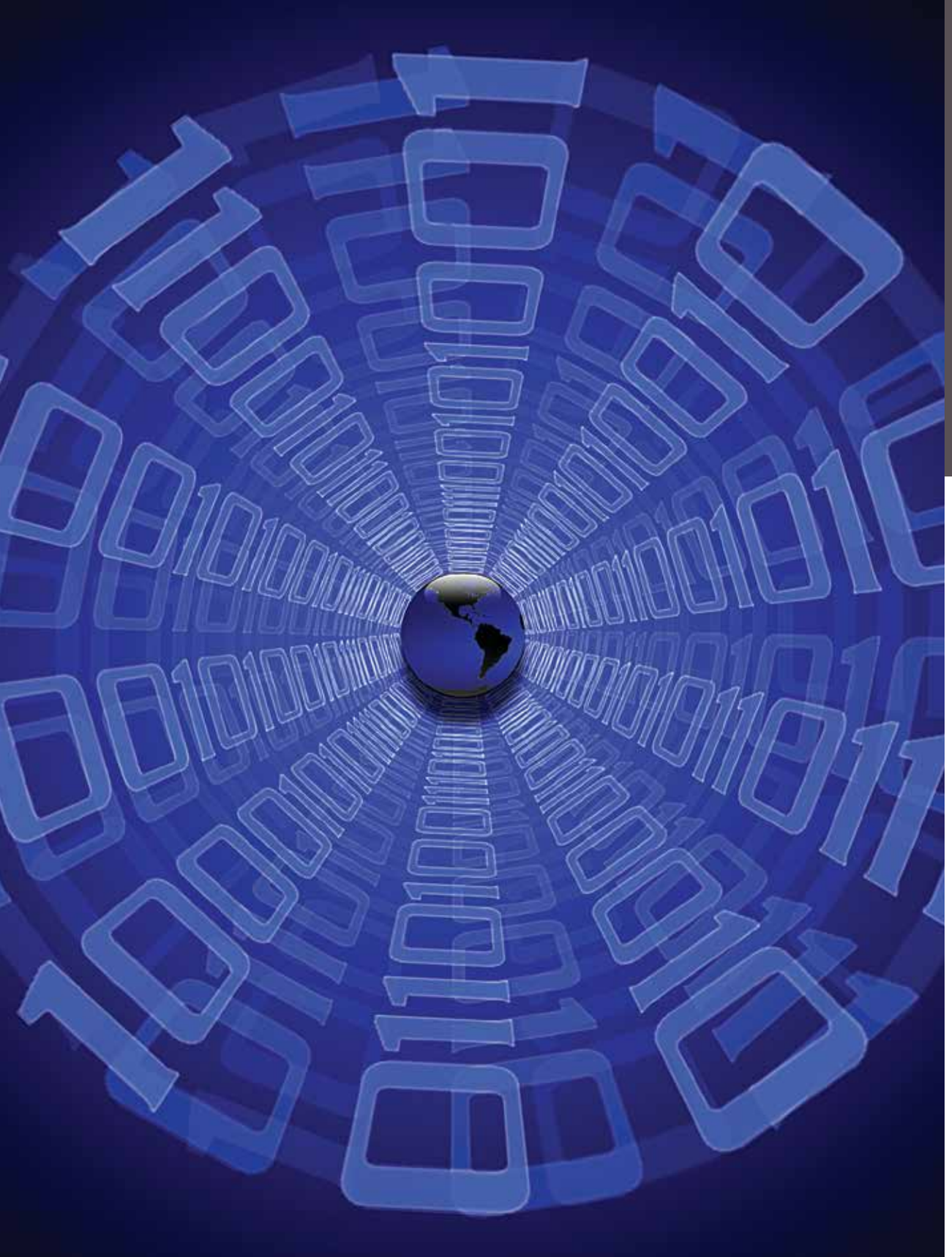
There is also a growing need for technological capabilities that allow collaboration from anywhere and anyone at any time. This requires the creation of a master data set, which ensures that the data is secure, while allowing that it is also accessible simultaneously by multiple users. All this will ultimately help reduce risks, boost efficiencies and subsequently drive the discovery and production of more oil.

None of the above will be truly successful without entrenching best practice and data management awareness throughout operating companies. But introducing new ways of managing and evaluating data will require a mindset change away from the traditional structures and ways of thinking. Educating staff on the value of the data they are using and the need to handle it systematically and rigorously will be therefore be seminal to reap the benefits of putting in place the right infrastructure. Training and mentoring new engineers in these practices will equally be a must.

"Developing sound strategies to integrate and manage data and using it in smarter, faster ways can be a key differentiator for energy companies, affect project economics, and make or break the successful application and operation of technologies such as EOR in oil fields."

The importance of data gathering and management is also being recognized by national oil companies (NOCs) in the Middle East. Petroleum Development Oman (PDO), in which Shell holds a 34% stake, is a case in point. PDO's data management system is among the most advanced and, after years of implementation, has contributed to the company reversing a period of declining oil production through the application of various EOR techniques.

Just as data management has supported PDO's transformation into a leading EOR company in recent years, it will drive similar changes in other parts of the region. The industry's transformative years are far from over.



POST EASY OIL: THE ROLE OF IOCs IN FIELD OPTIMIZATION THROUGH EOR

HOST: CLEMENT EDWARDS - WRFM Manager JV Excellence PT Discipline Lead, Shell
MR. PHILIP MOSHER - General Manager, Baker Hughes Reservoir Development Services
MR. ROBIN MILLS - Head of Consulting, Manaar Energy
MR. LUIS FIGUERA - Senior Reservoir Engineer, ADCO
MODERATOR: DYALA SABBAGH - Partner, Gulf Intelligence

DYALA SABBAGH Clement - is this the right time to be implementing EOR in the region?

CLEMENT EDWARDS EOR is of course expensive to do, and so one of the things that we should think about is, are we ready for EOR, are we capable of developing effective EOR and have we got the basics in place to do it? Such data acquisition, advanced modeling techniques and the means to intervene in enhanced oil recovery floods to improve them, is essential.

One thing we should caution against is a rush to implement technology - buy a black box and bolt it on and then assume everything will be fine. If this is based on the wrong premise or poor data, we're in big trouble.

In this part of the world, EOR is becoming necessary, but companies are rushing into a complicated recovery mechanism with a very low experience base, so we need stronger foundations. For example in Oman, in cases where we've done the basics right and EOR is a natural progression, it has worked well. In cases where we haven't done the basics right, we struggle.

PHILIP MOSHER I agree - at the moment, we have a relatively high value on oil and it allows us to go forward with EOR. Some of the methods we started in the eighties are even continuing to be used because the value is there. But to make it more successful, we need to understand what we're putting into the ground and where the remaining oil is located. It's very important that we do these basics and as long as we do, we can work to reduce the cost to get that extra oil out and rely on high oil prices that we have at the moment.

DYALA SABBAGH And what if these high oil prices don't last? What's the economic prospect for EOR?

PHILIP MOSHER There are a wide range of costs associated with EOR. Some of the projects will continue while others which are more expensive will be temporarily delayed until prices go back up.

DYALA SABBAGH Does it only make economic sense to apply EOR to marginal fields?

PHILIP MOSHER There will be difficult oil in all fields, so even in the better fields there are opportunities to apply EOR. The question is where do we apply EOR? Do we apply it directly after primary production? Do we know enough to do it then? Or do we wait until after we've had, for example, secondary production - water flood? There are some tight rocks for example where if you're going to go with a gas injection, you're much better off to do it right after the primary as soon as you know enough about the reservoir and the flow patterns, to apply it.

DYALA SABBAGH Clement - how well is data knowledge being managed?

CLEMENT EDWARDS In most operating companies I've worked with or visited, data application is not managed as well as it should

be. And in EOR, the volume of data is between 1,000 and 10,000 more times intense than for a black field. All decisions are predicated on data, so without proper preparation it's anyone's guess.

DYALA SABBAGH Robin - what about CO2 EOR technology? Is this something that is being accepted and applied in this region?

ROBIN MILLS The first thing you think of when you think about EOR are mature fields. But actually, I think there's also a lot of applicability of EOR to fields which you wouldn't even consider as mature. One example is heavy oil, which can be found in the Northern Gulf region in particular. And another other example is CO2 EOR, which is a driver for EOR, but it also has of course an environmental driver. And in this country in particular it has a very important economic driver, more so than for example it would have in the U.S. or the North Sea, because you're freeing up natural gas or methane currently used for injection, and replacing it with CO2.

In terms of public acceptability, I think there's a bit of a division between CO2 EOR and pure CCS - carbon capture and storage - just for the disposal of CO2. We've seen in Europe, and partly in North America, there were some problems with public acceptance of CCS.

But that's not the case in this region where people are familiar with the oil industry which is the bedrock of the economy; a lot of people either work or are associated with the energy industry here and the fields where CO2 EOR is being applied are not near residential communities, so it's uniquely favorable in this region.

DYALA SABBAGH Putting aside the environmental benefit of using CO2 for injection, are other EOR techniques more favorable?

ROBIN MILLS We had the announcement yesterday of the joint venture between ADNOC and Masdar on CO2 transport and injection and that just shows how important it is. Because of the issue of freeing up gas, anything that can replace gas at a reasonable cost as CO2 can, is acceptable. There's a lot of attention on different components of a national strategy for gas of which alternative energy, including CO2 capture - which is a clean energy - is an important part.

LUIS FIGUERA Yes - we do need to look at what many specialists call "the Abu Dhabi gas dilemma". The fact is that 99% of the power in the UAE is supported by hydrocarbon gas, and at the same time we have our main EOR projects in Abu Dhabi also supported by gas. So a decision has to be made whether that gas should be used for the development of the economy, or to ensure the sustainability of oil production.

Gas demand in the UAE is increasing, especially in Abu Dhabi, by 11% every year, and by 2020 UAE energy demand is expected to have doubled. So CO2 is a very attractive option - getting the CO2 by-product from power generation and using it to enhance oil recovery and release gas for domestic consumption.

DYALA SABBAGH Philip - are there any useful lessons to be learned here in this region, from more established CO2 EOR applications elsewhere in the world?

PHILIP MOSHER CO2 has been used in Texas for a long time, and it's been used in other parts of the world. I have quite a bit of experience with OXY in those fields and I think there is a lot to be learned in terms of a combination of when to inject the CO2 and also in the water oil gas ratios that you use, tapering the ratios over time to get maximum recovery from a minimum use of CO2.

Every field is different and we have to pilot it here to make sure, so we can better understand how it works, but we can get a general direction from what other people have done.

ROBIN MILLS There's more and more interest to using EOR and testing out innovative EOR techniques here. Oman is a real great test case because they're doing almost everything in polymer floods and steam and so on. You have

> *"It's a key part of national strategy to have an EOR strategy, to look at what we will be doing with these reservoirs in 20 or 50 years and how much might we be able to extract from them. So laying the ground work now for the future and doing a few starter projects now."*
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> **ROBIN MILLS**

chemical EOR starting to be used here in Abu Dhabi. There's a huge center of CO2 here, one of the world's largest outside the permanent base in the US, so there will be a lot of learning.

DYALA SABBAGH You mention learning. Does this region have the human capital capacity and appropriate skills base to implement this EOR technology?

ROBIN MILLS A big part of EOR is building the skill base - that'll be a huge challenge in training up the next generation to be really capable and skillful, bearing in mind that you do not have many real EOR gurus and experts.

DYALA SABBAGH Clement - do you see that this as an issue?

CLEMENT EDWARDS Yes - it's a big challenge. But if you can get graduates who are willing and able to learn, you can do enormous amounts of work with a few key experienced coaches and mentors. One mentor with six young graduates can produce wonders if they're well-mentored because they have the capacity, that's the point.

PHILIP MOSHER I think one of the things we have to realize is that as we go to EOR, and as we go to unconventionals, it's more intense in terms of engineering and we need more people. It's very important that we transfer our knowledge from other locations, and from the seniors that are left in the industry to the next generation.

DYALA SABBAGH Is this knowledge transfer happening effectively?

PHILIP MOSHER It is being implemented, but I do not see enough of it in place here in the Middle East.

CLEMENT EDWARDS If you look at PDO, they've got into web-based workflow management so that once you've captured the best practice, young engineers can come in and basically start workflow and analyze wells and they can even do it offline, so if they make a gross mistake you don't press the button and set a well differently. So it's letting them learn all the time from daily working practices.

I think we've moved away from the formal training - the chalk and blackboard in the classroom - to implied learning in workflow on a web, plus face to face coaching one and one.

I'm sure other companies do this too, but we also have programs where we cross-post staff from companies like ADCO or PDO, to somewhere else in the world, to get the best of the best learning for them, so it's a combination of systems.

DYALA SABBAGH We have a question from the audience.

AUDIENCE MEMBER Clement - the Minister of Energy for Oman recently said that we've been through what's coming your way neighbors (UAE) i.e. heavy water flooding, very great challenges. Do you

concur with the Minister's view in Oman and what should the region do, and is it doing it fast enough if that is the case?

CLEMENT EDWARDS Ironically, I worked in ADCO at a time when PDO was seen to be doing very well - and then they had a production problem, and it's all vested in the things we've discussed today - data management and modeling and doing the work properly. So I think the Minister is absolutely right; it's just a case of the maturity of both companies in both cases.

We had some of our colleagues from ADNOC visit recently and they were amazed that we were investing in a field with a 96% water cut. So they are seeing the fact that it's a change game, that they have to move towards understanding managing water, looking in much more detail at the reservoir, and the good news is they're taking that on board earlier and hence will probably be ready for it when it really happens. But yes, they're seeing what the Minister alluded to - the problems are just creeping in now in these big fields.

PHILIP MOSHER I find it interesting that we're spending so much time on CO2, because there are many other EOR techniques that are very applicable here.

DYALA SABBAGH Would you say any of the others override CO2?

PHILIP MOSHER I'm not going to say any of them override CO2 because CO2 has an environmental aspect as well, but there is a large cost to capturing CO2 when you don't have natural CO2 to inject in the ground. So if you look at other gases that can be missable - nitrogen is another one that you might consider. Plus you have a lot of other techniques - such as chemical and polymer; we had a paper this morning at the ADIPEC conference which presented a case which achieved as low as $12 a barrel for oil recovery for polymer, so it's a very viable process. There's a lot of additional oil to be recovered by water management and other methods.

But, it remains very important that we are piloting EOR - of which one is CO2 - so that we are in a much better position to implement them in the future.

ROBIN MILLS I agree - we shouldn't think about EOR as a switch that you turn on and off. It's a long-term process of developing skills, pilot projects and understanding the reservoirs. Some reservoirs will be right for EOR today, some will not be ready for EOR for many decades, but it's about having a strategy in place. In this region, these are giant oil and gas resources with very long lives. It's a key part of national strategy to have an EOR strategy, to look at what we will be doing with these reservoirs in 20 or 50 years and how much might we be able to extract from them. So laying the ground work now for the future and doing a few starter projects now.

DYALA SABBAGH How advanced is collaboration between IOC's on sharing technologies?

ROBIN MILLS I think there's a huge amount of that happening and under different structures - for example, Saudi Aramco has a model of doing it itself but in close collaboration with service companies. Abu Dhabi has chosen a much closer relationship with the IOCs as partners. The challenge is always how do you define a commercial deal between the NOC and the IOC and the technology company, so that everyone feels they're getting fairly rewarded.

DYALA SABBAGH What about sharing data?

ROBIN MILLS If we think specifically about this region, there is a general discomfort by countries or national oil companies to share data with their neighbors, but as they see how important data and proper information at reservoirs is, we see more willingness to share data across borders because essentially it's exactly the same reservoir all the way from Oman up to Kuwait and more or less right into Iraq and so on.

PHILIP MOSHER I just want to carry this thought of cooperation a little bit further. You have to be open to change; it's not just sharing the data, it's about being open to try the lessons that other people have learned. In the UAE, I'm seeing quite a bit of institutional resistance to this.

DYALA SABBAGH Clement - would you agree?

CLEMENT EDWARDS If we look at Oman for instance, the government has established a national data repository where people are obligated to put their data. So it's a two-pronged approach - the IOCs can play a great part if they're expert at something, be it data management or whatever, and it's also up to the host governments to insist upon the law being applied.

Drilling into the 21st Century Reservoirs Faces Next Generation HR Challenge

The future of drilling is as much about expertise and technology as it is about perception and communication.

As the oil industry is preparing to see as much as 50% of all petroleum engineers reach retirement age in the coming 10 years, concerns are rising that their exit will be accompanied by a drop in productivity as new entrants are likelier to make costly errors, operate at a slower pace and extract lower yields from more challenging hydrocarbon deposits due to a lack of experience. It will take newcomers years before being able to match the skills of their experienced predecessors.

For those in the drilling business, this is of particular concern given that the number of harder-to-drill wells is rapidly increasing as both national and international oil companies are forced to develop more geographically remote and difficult-to-access reservoirs amid limited access to easy oil reserves. Whether on shale developments in North America, deep-water projects in the Gulf of Mexico or challenging subsurface environments in Oman, an ever-bigger number of oil and gas wells are being drilled in difficult territories.

As a result, the set of skills required for drilling engineers has broadened too, reflecting the industry's entry into higher-risk areas and the application of constantly advancing technologies such as horizontal drilling. Risk judgment has become more important than ever at a time when the drilling risks are becoming significantly greater. Among the engineers needed by the industry today are those with the experience to execute drilling on complex, and potentially dangerous projects such as Abu Dhabi's Shah and Bab sour gas developments, the latter of which Shell is involved in.

To be sure, drilling for oil and natural gas—whether on or offshore—has never been a straightforward exercise. Drilling engineers have had to deal with high-tech equipment, volatile hydrocarbons and environmental conditions that may range from the ever-changing seas to scorching deserts such as Saudi Arabia's Rub al Khali, also known as the Empty Quarter. They also need the technical know-how to design the wells and drilling platforms for cost-effective operation, while at the same time maintaining the necessary safety levels.

But just as the oil industry at large is faced with an acute shortage of experienced engineers, the drilling sector too is experiencing a dearth of specialists. In response to this situation, the industry has introduced accelerated training schemes and launched drilling centers of excellence, among other initiatives, to stem the challenge.

Attracting new talent to the industry has also been at the forefront of companies' agendas. The flow of new talent into the oil and gas industry hasn't been able to match the outflows and keep up with increased demand at the same time. The development has pushed up the cost of retaining experienced professionals including drilling engineers and of training newcomers that were recruited from non-petroleum engineering disciplines despite lacking the qualifications needed to be of immediate use within their companies.

But today's gap of industry specialists isn't purely down to a lack of supply. It is also about the oil industry's image and how it is perceived among potential new young entrants. The petroleum industry is regarded very often as a twilight industry, while drilling specifically is being looked at as low tech as compared with Google and their Silicon Valley neighbors.

Neither is the case. With world energy demand forecast to double by 2050, the oil and gas industry will be around for many decades to come. And even though IPODs or wind power and may sound attractive to young students, there is still a lot more that can be done to exploit hydrocarbons—especially at a time when ongoing technological advances are enabling the extraction of previously inaccessible unconventional resources.

Going forward, to ensure and sustain a flow of new engineers—including drilling engineers—into the industry, stimulating interest among youth in engineering studies and creating specific degree programs will be seminal. At the same time, the industry needs to ensure greater knowledge transfer internally. This won't be possible without more emphasis on mentorship programs that ensure the wealth of knowledge among the soon-to-be-departing engineers will be passed on to new talent.

Shell, like other international oil companies, has also accelerated many of its training programs, which brings with it a very specific set of challenges given that new entrants still need to take the time to acquire the relevant competence. In addition, companies have to deepen collaboration with educational institutions around the globe to ensure industry requirements are being met. Given the speed at which the world—and technologies in particular—are changing today, the next generation has to be taught and trained in very different ways compared to 10 or 20 years ago.

The efforts shouldn't stop there. The industry needs to change its public perception and educate potential entrants on the career prospects it offers. If oil and gas companies want to attract the best talent in the future, they will step up their efforts on the communications front and make sure they reach the right audience with the right messages.

"The flow of new talent into the oil and gas industry hasn't been able to match the outflows and keep up with increased demand at the same time. The development has pushed up the cost of retaining experienced professionals including drilling engineers and of training newcomers that were recruited from non-petroleum engineering disciplines despite lacking the qualifications needed to be of immediate use within their companies."

DRILLING EXPERTISE: THE HUMAN RESOURCE CHALLENGE

HOST: ELEONORA LICHTENECKER, Senior Training Advisor - Drilling, ADCO
PASCAL AVIENGNE, Development Manager, Shell Abu Dhabi
BRIAN BIELSS, Drilling HSE Manager, Al Hosn Gas
DR. ALI AL SUMAITI, Assistant Professor, The Petroleum Institute, UAE
MODERATOR: DYALA SABBAGH: Partner, Gulf Intelligence

DYALA SABBAGH Brian - you're HSE Manager for Drilling at Al Hosn Gas, working on the very challenging Shah gas field project. Is talent capacity an issue for you?

BRIAN BIELSS I think the critical issue is how you manage your people that are already in the job, to give them certain skills once the project is up and running, and ensure that before you move on, they can step into your role. For example, develop a very strong mentoring program where you could say, within three years, I want three of these five people to be able to take my position.

DYALA SABBAGH Are there enough people though joining the industry to start with?

BRIAN BIELSS There aren't enough people coming into the industry, and it's very difficult to encourage young students to do this, especially from an HSE perspective when there are salary gaps, compared to for example a qualified drilling engineer where salaries are more lucrative. For us in HSE, the question is how do you create a desire for somebody to come into HSE? Part of that is bridging that salary gap, but the key is also to show the value that HSE has within organizations and that it's no longer a luxury, but rather a requirement.

DYALA SABBAGH Given the limited supply of talent for the industry's requirements in this region, companies still need to go in search of talent elsewhere, such as to Eastern Europe and other markets like China, where one simply finds a larger volume of engineers graduating. Eleonora - how can this challenge be addressed?

ELEONORA LICHTENECKER We need to attract more people to the industry and this requires a change in mindset, and requires us to portray a different image. If we do that, we can engage many people that maybe previously had not thought that it would be an interesting career to work in.

PASCAL AVIENGNE Yes - the image of this industry is crucial. I'm a driller. I've been a driller for the last 30 years, and I know exactly how we're being perceived among students. The petroleum industry is regarded very often as a twilight industry and drilling is regarded as a low-tech industry, so it's really our job to make sure that that perception is changed. We've got to explain better what we do. We've also got to explain that the oil and gas industry is going to be around for many more years. Renewables may sound attractive to young students, but there is still a lot we can do to exploit the hydrocarbons in the ground.

DYALA SABBAGH What does the industry need to do to make this happen?

PASCAL AVIENGNE We are offering training programs of quality; there are expectations from the youth of today that we should be training them to a higher level than before. Thirty years ago, we were happy to do a hands-on job for the rest of our lives. These days, young engineers want to see a clear career path. We need to promote research and increase the appetite to contribute to an industry which is progressing very quickly and embracing modern technologies.

DR. ALI AL SUMAITI Another important step is to nurture an interest in the oil and gas industry in children from a young age. For example, ADNOC has set up a school in Abu Dhabi which is focused on sciences from KG all the way to high school. We (Petroleum Institute) come in, and advertise our courses to these students to attract them.

DYALA SABBAGH Eleonora - how important is competence training and assessment on the job?

ELEONORA LICHTENECKER Most companies, like ADCO, have graduate programs where they bring the young graduates through to a certain level so that they can take on jobs. What we saw in ADCO was that something additional was needed - so for example we have a program where four times a year, engineers get together and exchange and compare experiences. Your team is only as strong as the weakest link, and so the idea is that you bring everybody up to a same standard.

DYALA SABBAGH Are these initiatives something the industry can do on its own, or do you have to have cooperation from academia?

PASCAL AVIENGNE We are working together. It's a seamless process from graduation. Institutions like the Petroleum Institute in Abu Dhabi keep in touch with us once their students join us and we also let them know what basic knowledge we need their students to have, in order for them to progress through the company efficiently, so that dialogue is ongoing.
A direct example of how R&D can make a difference is for example making more use of using data transmission technology. Instead of having a lot of people out in the field in the desert where nobody wants to be, if we can remotely control part of a drilling operation—and we already have tools to do that—then perhaps we can offer more attractive careers for young graduates. That's really what we should be selling.

DYALA SABBAGH Do you agree with Brian's initial point about the need for mentoring by senior employees and is this being implemented at all?

PASCAL AVIENGNE I think it's been recognized that there needs to be more transfer of knowledge. In Western Europe for example, there is a real recognition that mentorship should be valued; this not only ensures that experience and knowledge are transferred to the younger generation, but it also addresses the deficit in all our retirement funds. It's very much a fundamental societal change. We need to look at the more senior people with a lot more respect and we need to create the tools and give them the opportunities to transfer that knowledge better.

BRIAN BIELSS As experienced people get closer to retirement, often their workload increases drastically because companies try to squeeze as much knowledge out of them as they can.
I think it would be more beneficial to take the day-to-day workload off of those people, designate it to the young people underneath them, and let them strictly be mentors and have time to transfer their knowledge down.

DYALA SABBAGH Is there a risk to handing over responsibility too soon?

BRIAN BIELSS There is reluctance from management generally to place somebody in a job with little experience who could potentially make a mistake, but the key is if you give them

enough support and leadership, then that's where the benefit happens. The worst thing is to say "I know you only have six or seven years' experience; we need somebody that has 10 or 12 years' experience." If you do that, you lose that potential.

DYALA SABBAGH Are we seeing a situation where industry and academia are competing for the same talent and there's simply too little of it to go around?

BRIAN BIELSS It's kind of a dog eat dog world. We as a company have to have these people so we're going to go and get them, and spend whatever money it takes to get them.

One solution would be for companies to develop some R&D within the universities and for example, allowing young students to be involved in R&D but also drive their curiosity by taking them off site to see something practical like a drilling rig. Let them understand first hand from an early stage what it's all about - it's one way you drive that desire to excel in that field. So you need that participation from industry as there's nothing that a university can do to bring that experience.

DR. ALI AL SUMAITI We need to show people early on that it's worth remaining in the technical field. We don't want everyone to aspire become business managers. At P.I., we are currently interviewing a lot of employees of ADNOC and ADCO and planning to send them overseas to continue their post-graduate studies and to come back as a specialist in the company.
The culture of R&D and the needs of post-graduate specialists within ADCO have changed dramatically. I think there are really huge opportunities for those who are eager to seek science and to apply it. And at P.I., we have a very close relationship with not only IOCs and NOCs but also service companies.

The other area which requires cooperation between industry and academia is the challenge of finding PHD's and the professors to teach the students. Even in the U.S., there are only about 10 universities that teach petroleum engineering. So the industry has to work side-by-side with the universities in order to assure that enough professors remain in academia. At the same time, they should be well compensated through the R&D opportunities.

PASCAL AVIENGNE If you take as an example research at Shell, we used to have our own research labs so it was very much an internal activity. Now we're much more open to the world - we've built connections to the universities and we've externalized a lot of our research. We recognize that research is better done by academia and we are sponsoring that. Universities are the source of our fates and if they are happy, then we know that we are going to get the right people for our needs.

DYALA SABBAGH Brian - what about the idea of companies spending on skills transfer and training on interdisciplinary skills. Is that another solution to the human resource challenge?

BRIAN BIELSS I think we need to make it clear when people are choosing degrees that if you choose a technical course, there IS longevity for this as a career. That we need engineers to tackle the difficult fields that we need risk engineers. Lots of people want to know how far can I go. I don't want to be in a field that has a cap - I want to be able to accelerate.

DYALA SABBAGH So people need to feel secure that they can grow within the same company rather than take their expertise across to an IT company for example or any other industry that might be competing for their talent.

BRIAN BIELSS Yes - companies need to be willing to open up and let people progress frequently and as quickly as possible. When you start capping them and say you must be in this position for 5 years before you can move to the next position, people can get very frustrated. Young people, like me want to move quickly -the moment you try to stifle it they are going to leave.

DYALA SABBAGH:
Eleonora - what about the idea of recruiting people who aren't necessarily mechanical engineers or engineers at all, but who do have a scientific background and intelligent capacity to learn, and training them across disciplines once hired? Too costly?

> *"We need to attract more people to the industry and this requires a change in mindset, and requires us to portray a different image. If we do that, we can engage many people that maybe previously had not thought that it would be an interesting career to work in.*
>
> **ELEONORA LICHTENECKER**

ELEONORA LICHTENECKER If you go to the root source, you have a human being at the end. We, in drilling, hire a lot of architecture students now because they are engineers. For example, the HSE department could start looking into areas where there are psychology students who can apply their skills of conviction on a certain project. So what we do at ADCO is we train them, we look after them and then they can implement their skill set to the job at hand; that combination becomes much more powerful, because an architect for example will have a very different view on a structure than an engineer.

PASCAL AVIENGNE We are screaming for diversity. The world these days is actually moving away from diversity and that's really something that we've got to fight. I was trained as an engineer to start with and I did an MBA. I've been back and forth between technical, business and sales positions, and that's worked well for me professionally.

DR. ALI SUMAITI Diversity is something that we strive for also. As long as the person shows a passion for learning, you can take them and guide them towards satisfying their own and the company's professional needs.

BRIAN BIELSS I agree - a degree is there to show that they have the capability to learn. Thereafter, you teach them the skill sets that you're going to need in the industry.

ELEONORA LICHTENECKER I think what we need to realize is that we will have individuals who want to move fast and some who need a slower pace. Even if you're a famous gamer, it takes you a while to become a famous tennis player. So you need to put the work in. For people who are willing to work, there are companies who are willing to support them academically and in their job and give them job satisfaction. That's what will enable us to retain people, because at the end of the day if they have job satisfaction and feel that they are being respected, they will stay.

Future of Energy Innovation Depends on Attracting Generation Z to Science

By Saeed Alzaabi, Government Relations Manager, Shell Abu Dhabi

THE FUTURE of energy very much depends on the ability of today's young generation to drive innovation.

They are the engineers-to-be who will play a crucial role in ensuring uninterrupted energy supplies to the world, which—economic headwinds or not—will continue to see demand rise over the next decades. Meeting this energy challenge will to a large degree depend on a steady flow of students into science-related subjects to choose careers as petroleum engineers and researchers who will pursue technological innovations that will help meet future demand.

It's going to be a complex task that will require multiple stakeholders—industry, academia and governments—to engage and collaborate closely. Joint strategies and targets will need to be developed and executed because it is through collaboration that an "innovation culture" can be created to attract the next generation of engineers and scientists into a culture of curiosity to secure the future solutions of the energy industry.

The effort has to start with the very young. To this end, initiatives need to be drawn up that aim at capturing children's imagination from as early as primary school level and that sustain their interest through to university level and into professional life. Companies can play an active role in this, including by offering internships and building on competitions such as Shell's Eco-marathon, which combines engineering and energy challenges, and has been rolled out globally with great success.

At university level in the Gulf region—like in other parts of the world—there is a tendency for young people to choose social science studies over technical studies, which are perceived to be more difficult and offering fewer career prospects. This perception needs to be changed. To do so, companies need to take a much more proactive role educating students and their parents on the challenges and opportunities involved in entering technical studies.

Adding elements of Google and Silicon Valley, whose dynamic and vibrant start-up cultures draw in so many of today's graduates, would go a long way to boosting the oil industry's attractiveness to the X, Y or Z generation.

On the industry's side, it is essential we see more and accelerated graduate, training and development programs that follow a clear career path. Shell, like other energy companies, has been very active on this front. For younger people, especially graduates who join oil companies, having mentors is another important element in creating an attractive environment that gives newcomers an opportunity to see where they may be 10 years down the road and thus help their decision-making processes. Mentorship programs, which many companies in the industry already offer, also ensure the passing on of knowledge from experienced engineers to new talent.

There is also recognition that people's aspirations nowadays are different from what they were 20, 30 years ago. In a fast-paced world, today's young generation is keen to advance quickly and have more diversity in their job choices to ensure exposure to different roles in different geographic locations. These expectations need to be met.

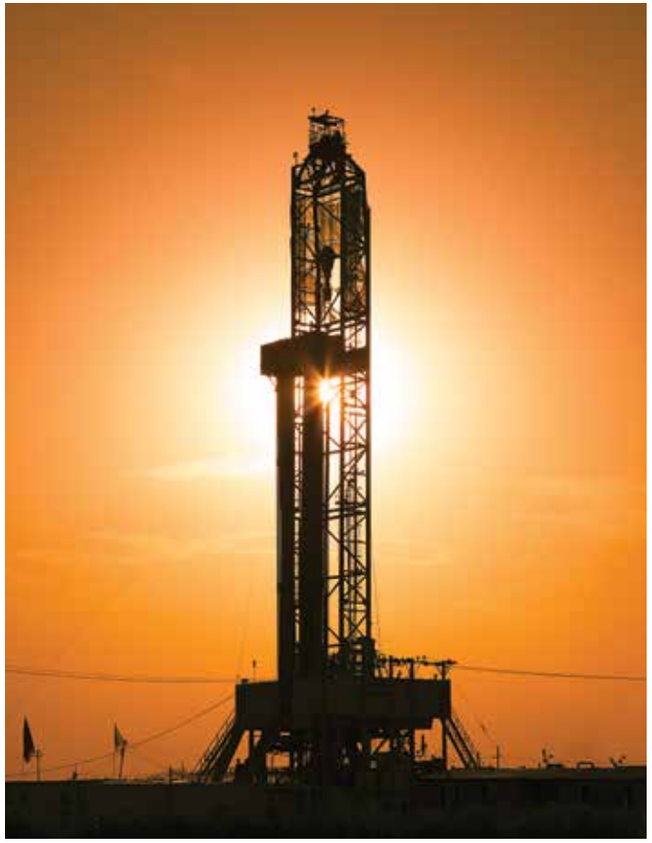
Generally speaking, multinationals have much to offer young graduates, whether it's unique opportunities to work on extremely exciting and technologically-demanding projects in an industry that relies on innovation to compete or the chance to take up roles in locations around the globe.

Meanwhile, closer collaboration between companies active in the energy sector and academia is essential to ensure that industry requirements and standards are being met. On the side of academia, the addition of more PhD programs would be an important step towards closer collaboration because it is at the advanced study level that universities can add significant value to industries. Partnerships between universities and companies already exist in the UAE and other Gulf States, and need to be intensified though joint research and development (R&D) projects.

Sciences and engineering in particular remain male dominated in the region, but women are starting to make an impact. In countries such as the UAE or Qatar, where local populations are relatively small, it is a great challenge to attract the numbers of students needed to sustain strategically important industries such as energy and grow into sophisticated knowledge economies. Ultimately, these countries need to develop education models that enable them to meet domestic demand for scientists and engineers from their own indigenous talent pools.

Governments have a leading role to play in this. They need to put in place long-term, integrated education policies that are sustainable over a generation or more.

Albert Einstein once said: "Science is a wonderful thing if one does not have to earn one's living at it." Einstein's words of wisdom still hold true in many ways today--science still is a wonderful thing—but luckily it is possible to make a very good living at it, including in the energy industry. Academia, industry and government need to make sure to communicate this to today's young to ensure the future of innovation is bright.



> *"There is also recognition that people's aspirations nowadays are different from what they were 20, 30 years ago. In a fast-paced world, today's young generation is keen to advance quickly and have more diversity in their job choices to ensure exposure to different roles in different geographic locations. These expectations need to be met."*

THE FUTURE OF INNOVATION: WHAT SHOULD INDUSTRY, GOVERNMENT AND ACADEMIA BE DOING TO INCENTIVISE TOMORROW'S GENERATION INTO SCIENCE

HOST: SANA BARDAWIL, Director of Communications MENA & Senior Business Communications Manager, Upstream International, Shell
DR. RICHARD GIBB, Executive Dean of Engineering, Higher Colleges of Technology, UAE
RYAN MCPHERSON, Regional Director (Middle East & APAC), ITF Energy
SAEED ALZAABI, Government Relations Manager, Shell Abu Dhabi
MODERATOR: DYALA SABBAGH, Partner, Gulf Intelligence

DYALA SABBAGH Sana - how effective do you think collaboration has been is in this region between government, industry and academia to encourage the youth of today into science?

SANA BARDAWIL Thank you Dyala. I think there's a lot going on and not just in the UAE, but also globally. The energy sector works very closely with academia and with government, but there's always room for improvement or for doing things differently. For example, more encouragement to students about science early on at school when they are still forming their primary ideas about what they see themselves doing later.

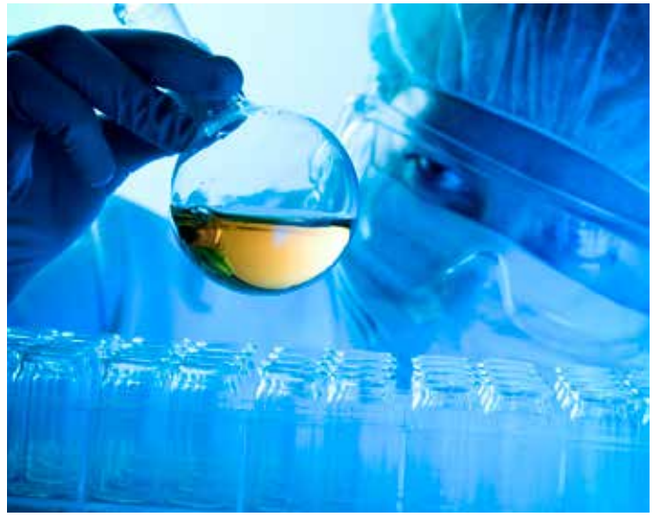
DYALA SABBAGH Do you see a direction in government educational policy towards this?

SANA BARDAWIL Definitely. One of the key programs is called "Think Science" established by the Emirates Foundation, which is supported by Shell, and is an example of industry working with both government and academia and targeting school children.

DYALA SABBAGH We're actually joined in the audience today by Humaid Ali, a "Think Science" ambassador and a recent graduate of the American University of Sharjah. Humaid, you're now working in cyber security at the TRA but can you tell us a little about the "Think Science" program and what it's targeting to do?

HUMAID AL ALI "Think Science" targets high school students and university students to participate in practical science and engineering projects, instead of just theory. The students develop a project, make a demo and present it for example to companies who sometimes choose to develop it with them. So that's basically the idea. It's important because that's where you get to see what's really happening in the industry.

DYALA SABBAGH Ryan - how important do you think these practical opportunities are for students?



RYAN MCPHERSON A text book example from ITF is one where we've started inviting some students from local universities in to work alongside us. We're actually working with a lot of innovative companies as well who have young graduates - either just started with them, or in placement. And this is extremely important because it allows them to utilize a skill set and be mentored. This last point is a huge element - the industry is starting to lose some experienced heads, there are new people coming in, but there's that skills transfer that needs to be done. So the idea is that we need to get that transferred through to the younger minds, and you can mentor them in a practical environment.

And I absolutely subscribe to Sana's point of getting to children early; university's too late, you've got to plant the seed at a school level so that you realize the world of opportunity that science has to play.

DYALA SABBAGH Sana - do you find that people who are reaching retirement or who have already left the industry have an appetite to take up this mentoring role that Ryan refers to?

SANA BARDAWIL I can't speak on their behalf, but I see a lot of energy in that

> *“Generation Y - your millennials - are now coming into this industry. They want more than just a paycheck at the end of the month; they want to be challenged; they want the ability to travel; they want a degree of responsibility; they want to be mentored; they want to learn continually on the job; they want to apply what they’ve learned at university—they want it all.”*
>
> **RYAN MCPHERSON**

space; people who’ve had very worthwhile careers in technical fields and who have a lot of passion to mentor younger people. And I think for younger people, especially graduates who join a company, having a mentor and a role model is key. We’ve mentioned linking experience to reality; a mentor makes it much more real, identifies the next career move and makes it possible for a new recruit to see themselves in ten years’ time and to make the right choices.

DYALA SABBAGH Dr. Gibb - how strong an appetite are you witnessing from young men at high school level to join the Abu Dhabi Men’s College? Are you having to go out and recruit them in?

DR. RICHARD GIBB A bit of both I think. This general topic of industry, academic and government collaboration is quite complex. The pre-university school period is quite critical, is very different and requires different policies to university which is more industry-focused. Then after industry, after university, you’ve got the research agenda which is also critical and has a completely different agenda.

On your question about getting students into the HCT, we have 22,000 students in the United Arab Emirates and there’s a great demand for engineering and science, but we still face intense competition from other subject areas. You have to try especially hard to convince the students of today to take all those demanding subjects. Right or wrong, social sciences are perceived to be easier than technical

sciences, particularly engineering. That’s a huge challenge for our students to address; why should they study something that is academically more challenging and that may not massively affect income potential?

DYALA SABBAGH So do colleges need to be campaigning to high-schooners that the technical sciences are in fact more exciting and rewarding than perceived?

DR. RICHARD GIBB There are two things: one is to generate that love of science which starts at school. The Shell Eco-Marathon is an example where you can have an incentivising experience doing science. Secondly, to highlight that the career trajectory is now better with science and engineering and technology. So it’s getting that message across in a very positive and proactive way.

The UAE Ministry for Higher Education has actually embraced quite an enlightened policy in this country to promote that.

DYALA SABBAGH Saeed - Dr. Gibb mentioned the Eco-marathon - a local idea that’s gone global and with great success.

SAEED ALZAABI The Eco-marathon is a huge project. As an Emirati, I was not expecting our national youth to be so innovative and creative but when I saw the UAE car and flag represented at the first Eco-marathon, I was really proud. Of course this initiative couldn’t have been achieved without the support of Shell and HCT. Next year, we’re going to have 6 cars from the UAE, the highest number in the region, entering the Eco-marathon competition in Manila which demonstrates how enthused students are about this initiative.

DYALA SABBAGH Ryan - Dr. Gibb mentioned earlier that HCT faces stiff competition in enrollment from other colleges and disciplines. How important is it that industry cooperates with academia on this?

RYAN MCPHERSON It’s really important to get the message across that the career trajectory and the vocational relevance of science and technology are important, to convince a student. And it also makes it more fun which produces better students and better results. The Shell Eco-marathon is a good example - designing a car is quite a small amount of time in the student’s life experience of the four years but it’ll be the bit they remember with so much pride and so much value. So those little things are disproportionately important for the student experience.

We must not however discount the importance of studying the theory also - whether it’s in medicine, law or engineering - it needs to be there to be valuable to industry.

DYALA SABBAGH What about the importance of financial incentives in the decision making process of whether to study sciences. How important is that in a high school student’s psyche?

RYAN MCPHERSON Generation Y - your millennials - are now coming into this industry. They want more than just a paycheck at the end of the month; they want to be challenged; they want the ability to travel; they want a degree of responsibility; they want to be mentored; they want to learn continually on the job; they want to apply what they’ve learned at university—they want it all. This industry is extremely well placed to deliver that. There is a concern that some of the other industries are deemed to be more attractive at the outset so that’s the area as an industry where we could perhaps sell a little bit more.

SANA BARDAWIL Yes and we need to also realize that students do their homework very well. At Shell, we have something called The Graduate Program for which we have many more applicants than places. And I think two things are clear. You mentioned travel; I had a boss who graduated with a technical degree and I remember him saying he was looking for a career that offered him travel, and it was either going to be the energy sector or the army. So he moved into the energy sector.

It’s also a good thing to use technical skills on exciting new projects and its multi-nationals like Shell and others who can offer these young graduates really unique opportunities.

DYALA SABBAGH Ryan - what about companies collaborating on joint programs - pooling their resources and not overlapping on the initiatives that they’re taking. Or is there a need and room for everyone?

RYAN MCPHERSON On areas like environment and safety, it makes more sense to collaborate than everyone doing that independently; this is where there is a meeting of minds between the oil companies, the energy companies and academia. And we found that from an ITF perspective, academia are extremely good with the ideas, the new knowledge, they are moving things on, linking up with industry, across industry to make that commercial. I think we could do more, but certainly the appetite is there.

DYALA SABBAGH We have a question from the audience.

AUDIENCE MEMBER Hello - I come from a technical background; I'm a geologist and I just finished my MBA. Throughout my professional life, I feel I've dealt with a cultural bias against the sciences here in the Arab world where people seem to favor or promote jobs in the medical or legal field for example. How do you tackle this issue?

DYALA SABBAGH Saeed - can I put that question to you? As an Emirati, do you feel that there's a cultural stigma in the UAE to join the sciences? Are parents for example encouraging their children towards the sciences or not?

SAEED ALZAABI I'm going to give you an example. My son finishes high school this year and I've pushed him to study science and to join the Petroleum Institute in Abu Dhabi. And in fact, many parents nowadays want their children to focus on science rather than other fields. As a country we recognise that we need more engineers to support our resources for better development.

DYALA SABBAGH Sana - from an industry perspective, how challenging are Emiratisation targets to your recruitment strategy?

SANA BARDAWIL I think you have a very good talent base in the GCC and the UAE definitely. The key for recruiting is having enough positions to place them. In Qatar for example, we have exceeded the number of Qataris in the quota in both technical and non-technical fields.

DR. RICHARD GIBB Emiratisation is a key driving issue for the country and for HCT. When you have 22,000 Emirati students, it's a huge positive stimulus to Emiratisation but the demand for those students is also enormous and once they're sort of locked into some form of career trajectory, it leaves little capacity to service all the demand coming from companies to recruit our graduates. The Emiratisation strategy is a real challenge for us colleges, because if, as a student, you want a doctorate in engineering, the college cannot then compete with Shell, ADNOC and ADGAS, to retain you.

DYALA SABBAGH So it's difficult to encourage students to do PHD's?

DR. RICHARD GIBB HCT is not a Ph.D-awarding institution but it goes up to Masters level and a very small percentage go on to do Ph.D work. Having said that, the willingness of companies like Shell and ADNOC to promote life-long learning, to support students, to support their employees to do Masters programs, has been very positive.

The Shell WFES 2014 Knowledge Series

Solving the Water-Energy Puzzle: The Need for Integration and Collaboration

Anna Halpern-Lande, Senior Manager, New Business Development for Renewable & Future Energy, Shell

In a world where water and energy are inextricably linked, water scarcity is the biggest threat to our ability to meet future energy demand. Or, in other words, meeting the world's future energy needs depends on water availability. Whatever way you look at it, securing both water and energy supplies for a rapidly-rising global population won't be achievable without concerted efforts to seek integrated solutions to the resource nexus.

On our planet today, the agriculture, industry and energy sectors—together with sanitation—consume enormous amounts of fresh water – a resource that's increasingly in limited supply. Of the world's total water resources, 97.5 percent are in the form of salt water from the oceans. Only 2.5 percent is fresh water, of which about two-thirds however are frozen in glaciers and ice caps, leaving less than 1 percent available in fresh groundwater.

Over the past 50 years, pressures on these fresh water resources have multiplied driven by rapid population growth, increased urbanization, poor water management and wastage. According to the U.N. Food and Agriculture Organization (FAO) and UN Water, global water use has been growing at more than twice the rate of population increase in the last century.

This trend isn't going to stop any time soon. Over the next 40 years, the world's population is predicted to grow to 9.1 billion from 7 billion, putting more stress on existing water resources to meet food, energy and industrial requirements. The situation is aggravated by the fact that 85% of the world population lives in the driest half of the planet.

In the Gulf region specifically, one of the world's most arid geographies, excess water consumption has become a serious issue. On a per-capita basis, Saudi Arabia and the U.A.E. consume 91% and 83% more water than the global average, and about six times more water than the U.K., according to an analysis by Booz & Company.

At the same time, global energy demand continues to rise and more water-intensive methods are being applied to extract more difficult to access hydrocarbons such as oil sands to ramp up supplies. According to the International Energy Agency's World Energy Outlook, the scale of water use for energy production is already large: some 580 billion cubic meters of freshwater are withdrawn for energy production every year, accounting for about 15% of the world's total water withdrawal, and second only to agriculture.

As such, the interconnection of energy

and water sits at the core of the oil industry's great challenges of the 21st century. A better understanding of the nexus relationship is required to develop integrated and innovative strategies that deliver greater energy and water savings and associated environmental benefits. New forms of partnership and collaboration with governments, academia and across industries will be required to do so.

Naturally, the oil industry has a key role to play in this, for example, by effectively managing the overall use of water through new and advanced recycling and reuse technologies. Shell's Pearl GTL project in Qatar is a good example. At the plant, Shell and its partner Qatar Petroleum use a highly-integrated system that doesn't need to draw on the Gulf state's scarce water resources. The zero liquid discharge solution applied at the plant means the water produced in the transition from gas to liquid is channeled to an effluent treatment plant, where it is treated and reused in the production process.

The treatment plant has a capacity to handle 45,000 cubic meters a day.

There are plenty of other examples of new approaches and advanced technologies assisting in the reduction of the amount of water the oil industry uses in its operations. In Oman, Shell is using reed beds to clean water produced with oil, which essentially saves the energy needed to pump water back into the ground. At the SAPREF refinery in South Africa, in which Shell holds a 37.5-percent stake, recycled household water is being used instead of fresh water. Other oil companies are adopting and implementing similar approaches and solutions.

Other technical solutions to more efficient

water usage in the energy sector revolve, for example, around dry cooling techniques for the cooling of thermal power plants, which requires large amounts of water. In addition, research is being carried into the energy efficiency of bio fuels and seawater desalination.

To be sure, these are important initiatives. However, they are still small pieces in a complex puzzle that will only be resolved by integrated efforts among all stakeholders involved – globally. This will take time. So rather than waiting for policies and infrastructure to fall into place, the oil industry has decided to take a leadership role in developing new ideas and solutions. This is an important first step and hopefully one that generates sufficient momentum, also beyond the oil industry, to build the collaboration needed to tackle the stress nexus.

> *"The interconnection of energy and water sits at the core of the oil industry's great challenges of the 21st century. A better understanding of the nexus relationship is required to develop integrated and innovative strategies that deliver greater energy and water savings and associated environmental benefits."*

LEVERAGE WATER-ENERGY NEXUS WITH FUTURE PARTNERSHIPS?

HOST: ANNA HALPERN-LANDE, Senior Manager, New Business Development for Renewable & Future Energy - Shell
DR. TAHA OUARDA, Professor & Head, Institute Center for Water and Environment- Masdar Institute
ROBERT KLEIBURG, COO, ECN (Energy Research Centre of the Netherlands)
DR. MOHAMED SALMAN ALHAMMADI, Director of R&D - Abu Dhabi Food Control Authority
MODERATOR: DYALA SABBAGH, Partner - Gulf Intelligence

DYALA SABBAGH: I would like to start this discussion by looking at this region - the Gulf - where we have specific demographics, a particular geography, an indigenous energy industry and a very high per capita rate of water and energy consumption. On average, consumption of water in the Gulf is 80% higher than other parts of the world, and this is in an environment where water is scarce. So we will look at the supply and demand dynamics around that and related solutions.

Dr. Ouarda - if I can start by asking what you see as the most prevalent problem facing the Gulf today on the water scarcity issue?

DR. TAHA OUARDA: We often look at water, energy and food production in this region separately, but we also need to integrate the concept of land use into the equation because the same land that you are using to produce energy for example through solar panels, you can also use to produce water or food. And good land in this region is limited, while demand, population and industrialization continue to increase.

Desalination dominates the water budget in the region. However we need to give more attention to the natural part of the cycle - which is precipitation and groundwater. The Gulf used to function just from precipitation and ground water, but with ground water resources being over used, precipitation should be utilized and integrated into the equation more efficiently. This country has over 100 dams in the eastern region and we need to integrate that water that's being collected and make a better assessment of its potential.

At Masdar, we've been working on some climate modeling for the future, and existing data shows that precipitation is actually increasing in the UAE.

DYALA SABBAGH: And is that missing because of a fixed mindset that needs to shift, or is it a cost issue?

DR. TAHA OUARDA: It's probably both.

DYALA SABBAGH: Anna - on partnership and cooperation between the different sides of this equation that have to apparently integrate better, do you see any steps being taken to address that?

ANNA HALPERN-LANDE: I'm a little less familiar with the policy side, but as an industry we look at things project by project, asset by asset, but I would also echo my fellow panelist's comments on the need for integration.
For example, using fresh water in the oilfield and then throwing it away is an opportunity missed. We need to seek integrated solutions on re-using and re-injecting the water either back into the reservoir or if it's clean enough, bringing it back into the water basin.

In South Africa, we take waste water from a municipal waste water facility and put that into a refinery. In Canada we answered a municipal wastewater treatment plant RFP and now some of the treated water from the wastewater treatment plant supports the water needs in the local upstream asset that we have nearby. These are the kinds of solutions we need to have in the Gulf and it may take changes in policy and implementation of the necessary infrastructure to achieve this; if we were to take waste water today and try to bring it down to the oilfields in the UAE, there's no pipeline infrastructure for that yet.

DR. TAHA OUARDA: In the UAE, used water is treated - then about 50% is re-used for landscaping purposes mainly and about 50% is returned to the Gulf, which is unfortunate. That is water that has already been desalinated and treated - water that could be re-used for consumption.

So we should be thinking about optimizing the use of treated water. This resource can find a lot of uses in a number of fields. Why aren't we doing that? Partly because the infrastructure is not available, but there is also a negative perception associated to it (it is not clean water).

DYALA SABBAGH: Dr. Alhammadi - you are from the Abu Dhabi Food Control Authority.

Maybe you can shed some light on the thinking of policy makers towards these matters?

DR. MOHAMED SALMAN ALHAMMADI: Today, world water is facing three issues: pollution, population, and access to the fresh water. The same water that existed on earth billions of years ago still exists today. In my view, we need an integrated water management system. Abu Dhabi Emirate has put significant efforts to overcome water issue. One of the projects we have in Abu Dhabi is taking excess water from desalination and pumping into two groundwater reservoirs in Abu Dhabi. Another is a pilot project to use treated waste water in agriculture, in 216 farms, where we are evaluating the impact of treated waste water on environment.

DYALA SABBAGH: Anna - is it commercially realistic do you think for oil and gas companies can in the near future to strategize production more specifically towards water efficiency?

ANNA HALPERN-LANDE: We are primarily an oil and gas company, but we do have a group that's focused on future energy options and they're looking at things like concentrated solar. For example, GlassPoint, a concentrated solar thermal company is generating steam for EOR in Petroleum Development Oman's Amal field, has provided us with a concentrated solar option that we apply for EOR and it does three very important things. It saves a gas because we're using solar to generate the steam. Secondly it can take re-used water, and thirdly in the long-term, we do believe that this could be an option for either heat/steam needs and/or a source of processed steam, not just for Shell, but for other industrial parties.

DYALA SABBAGH: Robert - how do you see the energy mix changing in the context of the issues we've been discussing? Can renewables play a significant role in the solution?

ROBERT KLEIBURG: We've been speaking a lot about the challenges that we're facing here in the region. But of course the water-energy-food nexus is a global challenge. The IEA has calculated that water consumption by the energy industry will grow by 85% by 2035 compared to 2010 and that is a problem

because water levels are already stretched.

If you look at the water consumption for various energy technologies, it differs quite dramatically. On one extreme, we have solar photovoltaics and wind energy where we hardly use any water. Then we have other forms such as conventional oil and gas production which are modest consumers of water, and on the other extreme, we have very high water usage for biofuels and for some of the extraction technologies such as water flooding for shale.

Today, the energy industry looks at energy transition through the climate lens and also through the impact on dependency on other countries. I think what this water-energy-food nexus is requiring us to do is to also look at the energy transition from a water constraint point of view.

So in both the policy and scientific arena, we need to get our minds behind what it actually means to be water constrained, and what is the price of water going forward.

DYALA SABBAGH: What about the R&D? Is enough being invested to find solutions to these problems?

ANNA HALPERN-LANDE: From our perspective, natural systems and green infrastructure is a key part of how we believe the R&D effort should go. Such as putting some of our waste water towards greening; when you green you actually create a reservoir of water on top of the land, in the soil that is created, that then greens the area around and creates a better microclimate for growing food, has the potential to reduce the local negative impacts on global warming

ROBERT KLEIBURG: We also need to remember that most of the growth in water and energy consumption is not in Europe or the U.S, but in developing countries. There's a tremendous need there for knowledge on developing water and energy infrastructure, and how mistakes made by others can be avoided.

DYALA SABBAGH: Let's talk a little bit about demand side management.
Subsidies on electricity and water throughout the Gulf make consumption very cheap.

Does that at all impact the speed at which, for example, renewables are being developed or deployed?

DR. TAHA OUARDA: I believe that all the Gulf countries now are aware that if they don't integrate renewables in their grid and start meeting at least a part of the demand from renewables, that most of their fossil fuel will go to meet local demand, and so that's going to affect their export capacity.
We do see an effort for the integration of renewables now all over the region.

ROBERT KLEIBURG: There's over $500 billion of fossil fuel subsidies in place and that stimulates the inefficient use of fossil fuels, including in water production. At the same time, total investment in renewable energy technologies is only $250 billion so when you put that in perspective, it's ridiculous.

DYALA SABBAGH: Just as there have been incentives for businesses and countries that produce lower carbon emissions, could a similar model be set up for water use and efficiencies?

ROBERT KLEIBURG: In essence, you're talking about a quota system and it can be used for water consumption as well. Of course, it's all about giving a price to water, just as there's a price to carbon.

DYALA SABBAGH: Well, water is going to be the commodity of this century, isn't it?

ROBERT KLEIBURG: Yes and if we do set up such a system, that then allows business to take that into account in their decision making in a rational way.
The UAE produces about 8% of its own food and it's all irrigation fed and so has a high energy consumption. In other parts of the world, of course, the circumstances for growing food are less energy intensive. So, as a world, we need to find an optimum between growing food in places where the conditions are favorable and producing oil and gas where it's easy to find and extract. Trade definitely has a role to play in finding that global optimum.

DYALA SABBAGH: That brings us back to the

> *"Using fresh water in the oilfield and then throwing it away is an opportunity missed. We need to seek integrated solutions on re-using and re-injecting the water either back into the reservoir or if it's clean enough, bringing it back into the water basin."*
>
> **ANNA HALPERN-LANDE**

importance of partnership and cooperation for solutions.

Dr. Ouarda - some concluding comments from you as to what you see as the most pertinent action to take today on these matters.

DR. TAHA OUARDA:
I see a lot of potential and we have to work on things little by little. We need to market knowledge more successfully to individuals, as to what they can be doing to reduce waste, and legislation and policy can also help tremendously in this field.

ANNA HALPERN-LANDE: I think collaborating together and developing solutions together is crucial.

That's something we're very excited about and that we're actually actively doing.

And then I think every society is different, so in some societies pricing water works well, in others that's not feasible and so, the role of leadership can be very important in driving changes in behavior.

DR. MOHAMED SALMAN ALHAMMADI:
I have some final comments regarding R&D, which in my view is very weak because of a lack of funding here. There is limited contribution from the private sector. Take the U.S. where the contribution of the private sector reached 70% of the budget assigned for the R&D. where in most Arabic countries, the budget for R&D from the government is below 0.1%.

DYALA SABBAGH: Given that the government here has the resources to allocate more to R&D, and that the issues of water scarcity and water security are so prevalent in this geography, why aren't we seeing a bigger commitment to R&D? A global R&D center of excellence for water management for example?

DR. TAHA OUARDA: Many R&D budgets allocated elsewhere in the world are influenced by tax incentives and as that's not applicable here, we need to find other incentives.

You also need to build a culture of the private sector being involved with academia and developing tools that will be useful to them. It takes time to build that confidence that trust and we need to build the overall framework and a structure where the information circulates between academia and the private sector.

Resolving Water, Food, Energy Nexus for up to 10 Billion People to Define 21st Century

Wim Thomas, Chief Energy Advisor, Global Business Environment, Shell

If the energy crisis was a defining feature of the late 1970s, the water-food-energy stress nexus could well be a defining feature for the next few decades.

Today, the nexus tops the agendas of governments, businesses and multilateral organizations around the globe amid widespread recognition that the tightly intertwined nature of the world's vital resources—water, food and energy—is under increasing stress.

There have been occasional resource supply shortages and commodities price spikes due to temporary events such as a global economic crises, wars and natural disasters. But by and large, food and easy access to energy and water have been taken for granted historically.

Most industries have operated in a world of relatively plentiful and ever-cheaper resources with new technologies ensuring a rough balance between global supply and demand. However, that has begun to change, with global forces dramatically altering this equilibrium.

The world's population is projected to increase by some 2.5 billion people over the next 40 years, putting increasing strains on the environment to provide the food, water and energy necessary to continue economic growth. UN Water predicts a 70 percent increase in food demand by 2050 as a result.

With large parts of the global population growing wealthier, dietary habits are changing too, with more consumption of meat and dairy products, whose production is more water and land intensive. This dietary shift has had the greatest impact on water consumption over the past 30 years and is expected to continue, according to The Food and Agriculture Organization of the United Nations (FAO).

To meet world food requirements, agricultural output will have to rise substantially, pushing up both water and energy consumption. Water for irrigation of agricultural land already accounts for as much as 70 percent of all fresh-water withdrawals worldwide.

Climate change may alter rainfall patterns, drying up water supplies in some parts of the world and over-delivering them in others. Over the next two decades the world will need up to 40 percent more fresh water to meet rising demand. Many regions around the world—including the arid Gulf states—will face this challenge differently, but technology may not be able to tackle this on its own, and wasteful or excessive consumption will need to be addressed as well.

As a result of the growing population and the success of globalisation in lifting billions of people's income levels, the inter-connectedness of the food, energy and water sectors has become more apparent. Water is needed for almost all forms of energy production and power generation; energy is required to treat and transport water; and both water and energy are needed to produce food. With tighter supply and demand balances, water and energy-intensive industries and sectors are increasingly entering into regional competition.

A major global collaborative effort comprising all stakeholders will be necessary to find strategies for sustainable and integrated solutions that address the rising complexities of the food-energy-water stress nexus. What societies around the world now need is a more holistic approach to managing the nexus, possibly at increasing levels of complexity related to climate change issues.

Not only will collaboration create greater awareness of the interconnections between water, energy and food; it will also be an important tool in driving innovation and exploring new approaches. Shell is already working with organizations in the water and food sectors to improve our understanding of the nexus, for example by collecting and compiling data—there has been a lack of it in the past—that help address future water challenges.

Shell teamed up with the World Business Council for Sustainable Development and the University of Utrecht, to develop a new methodology to measure water use in industries. This has enabled us to estimate more accurately the amount of water needed to produce energy from different sources such as oil, gas, coal and bio fuels, or using different power technologies. Shell is also taking a much closer look at its own operations to understand in more detail how water is used. Over time, this has enabled us to reduce overall water use by improving water recovery and recycling.

Growing crops to make bio fuels, for example, can be water intensive and doing so in regions that face water scarcity could have negative social and environmental consequences. However, bio fuels from countries like Brazil, where high rainfall occurs, can make the difference. Still, even there one can see the nexus coming into play: when sugar prices increase for use in food, then bio fuel production goes down.

The complexities involved in the stress nexus are enormous. Whether it's the collection and evaluation of data and interconnections, the development of new innovative technologies or the introduction of relevant regulations, legal frameworks and policies – there needs to be a much harder push for enhanced, cross-sector and cross-industry collaboration and action among all stakeholders—governments, industry, academia, multilateral institutions and civil society—if the stress nexus is to be resolved.

> *"Today, the nexus tops the agendas of governments, businesses and multilateral organizations around the globe amid widespread recognition that the tightly intertwined nature of the world's vital resources—water, food and energy—is under increasing stress."*

FOOD & ENERGY BALANCE FOR 9 BILLION PEOPLE . . . ROLE OF RELIABLE DATA?

HOST: WIM THOMAS, Chief Energy Advisor, Global Business Environment - Shell
PROFESSOR JENS SCHMIDT, Head of iEnergy, Institute Center for Energy - Masdar Institute
ROD MACGREGOR, President & CEO - GlassPoint Solar
ASHRAF HAMOUDA, Head, Partnerships & Business Dev. MENA - UN World Food Programme
MODERATOR: DYALA SABBAGH, Partner - Gulf Intelligence

DYALA SABBAGH: The world's population is growing at an average rate of 1 billion every 12 to 13 years and is forecast to hit 8.3 billion by the year 2030. And over the next two decades, we are going to need 40% increased water supply. So studying today's production and consumption habits of energy, food and water and their impact on our climate and environment is crucial.

What we want to attempt to answer in this session is what has been done already about these challenges, what's been tried and tested? What can the energy industry do, what can government do in terms of policy and directives towards industry?

Should we be producing more food, or do we have to get more efficient at what we're already producing? By 2050, the middle class globally is going to hit 5 billion, placing great stress on food and energy consumption.

Ashraf - let's start with food production. This uses energy, and excessive production emits harmful elements into the environment, so where do you identify the biggest problem might be in that space?

ASHRAF HAMOUDA: We all put the stress on having to increase production. But we also have to know that 40% of our food is being wasted; whether from resources, from the agricultural point of view because of lack of storage, lack of distribution, etc., or in our own households. So we can't just keep on talking about game-changing innovations and production; that is always there.

We really have to start trying to save what we can. That's the low-lying fruit right there. And I think once we start understanding that, then we can start talking about distribution: what to produce better and how to produce it better.

DYALA SABBAGH: Let's look at the Gulf - is there a lot of wastage here? There aren't huge fertile agricultural areas after all.

ASHRAF HAMOUDA: What we need are regulations and set policies from the government; we need to have new irrigation potential instead of just drowning the land like we do; we need to be able to utilize the water better. In India, in Asia and Africa, there have been some great projects in the water space but you definitely need government intervention to start implementing what some of the innovations of the private sector have done.

DYALA SABBAGH: Dr. Schmidt - would you agree with Ashraf that there aren't strong enough policies in place?

DR. JENS SCHMIDT: I agree that people have to change the way they're living. Food is not just food. For example, opting to eat fish is a more sustainable choice than eating meat, because a cow needs more fodder to produce 1 kilo of meat compare to fish.

DYALA SABBAGH: What about technology?

DR. JENS SCHMIDT: We need to try to

develop technologies that use as little resources as possible, to produce as much as possible. Many of the technologies today are not efficient.

For example, if we're looking at windmills, every time we put one unit in, we get 20 units out; for fossil fuels, it's 1 to 50; while for biofuels it's only 1 to 5. So that's where the challenge is for technology.

DYALA SABBAGH: Can technology enhance food production?

ASHRAF HAMOUDA: Not exponentially anymore. That's why you really have to look at sources where you can maximize nutritional value.

DYALA SABBAGH: Rod - from GlassPoint Solar's perspective, where do you see technology helping to improve efficiencies in the energy sector?

ROD MACGREGOR: The energy industry is very complex and you can look at improving efficiencies at different places throughout the supply chain. We focus on the upstream side. Primary production of most of the world's oil resources is in decline and at the same time, demand is increasing. About half of incremental oil production over the next decade will be heavy oil, which is very energy intensive to produce. Steam is used to help extract the oil, which requires tremendous amounts of natural gas or an alternative fuel source to make the steam. So at GlassPoint, we focus on replacing that energy consumption with solar and it can have a dramatic effect. If just 1% of the steam used at today's oilfields was produced using solar energy, the reduction in carbon emissions would be larger than the emissions saved from all the electric vehicles ever built.

DYALA SABBAGH: Can solutions like this meet the incremental volume of demand that we're talking about?

ROD MACGREGOR: Well I would echo the earlier comments, that all of these things need to work together.

Here in the Gulf, gas is a very precious resource and more and more of it is being used for power generation, for desalination and to fuel industrial development. So the role of solar EOR is to release gas for those other uses.

DYALA SABBAGH: Ashraf - do you think there are enough regional or global platforms for people to discuss these matters?

ASHRAF HAMOUDA: The key word here is return on investment. If there is no ROI, no matter how many platforms you have, you're not going to have the results needed. I would like to see competitors within the same industry and people who are utilizing the same resources, cooperating for the national and international good. That's what we're lacking.

DYALA SABBAGH: Would sharing data be one solution? Rod, you've come up with this technology for using solar for EOR - would there be an advantage for you to share that knowledge for the greater good, if you like, and come up with further solutions to share?

ROD MACGREGOR: There was a term coined in Silicon Valley called "Coopetition," and in some areas, you compete fiercely and in other areas, you cooperate, and we do cooperate with some of our industry peers and various industry associations. One of the areas we collaborate most on is interaction with government, because regulatory changes affect all of us. In California for example we've come together as a group on climate change legislation, with some of the people who we compete with in other markets.

WIM THOMAS: I think transparency is increasing in this market and big data is

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>
> **PROFESSOR JENS SCHMIDT**

one of the big themes; the Googles of this world are going to do it for us, even if we don't. Industry realizes the complexity of it all, and realizes that one company or one government does not have the ability to do it alone.

ROD MACGREGOR: I'd like to add something here; there is a field which actually intersects with water and food and energy—and solar in particular—where we are all sharing data, and that's weather.

Satellites orbiting the earth collect weather data and we access it to figure out where the sunshine is. If you're trying to calculate how much steam or power you will get at a given location, there really are not enough ground stations today to be able to answer that question. So algorithms for analyzing satellite data are a problem and need to be improved.

Some of the early projects here in the region got off slightly on the wrong foot because the technology wasn't there to analyze the data properly.

ASHRAF HAMOUDA: We can talk about technology but it's really all about the politics - the economics and the numbers are easy, but nobody has the political resolve to put their foot down.

DYALA SABBAGH: So no one's taking the lead.

ROD MACGREGOR: The further downstream you go, the more important politics becomes because you're now talking about influencing the behaviour of millions of people, whereas on the other end of the scale, you're talking about influencing the behaviour of only tens of companies.

Companies react to economic opportunities or threats much more easily than regulatory ones. For example, making solar cheap enough to actually compete with fossil fuels. So let's make the economics compelling for everybody and then that change will ripple through.

DYALA SABBAGH: When we look at pricing, water, energy and electricity are quite heavily subsidized in this region, but given the strain on resources, would it not be viable for governments to reallocate subsidies to specific areas where they are most needed, such as renewables?

ROD MACGREGOR: As a capitalist, I prefer free market dynamics to subsidies. They're a very blunt instrument and they'll often create unintended consequences; take the U.S.'s activities on biofuels for example

> *"We all put the stress on having to increase production. But we also have to know that 40% of our food is being wasted; whether from resources, from the agricultural point of view because of lack of storage, lack of distribution, etc., or in our own households."*
>
> **ASHRAF HAMOUDA**

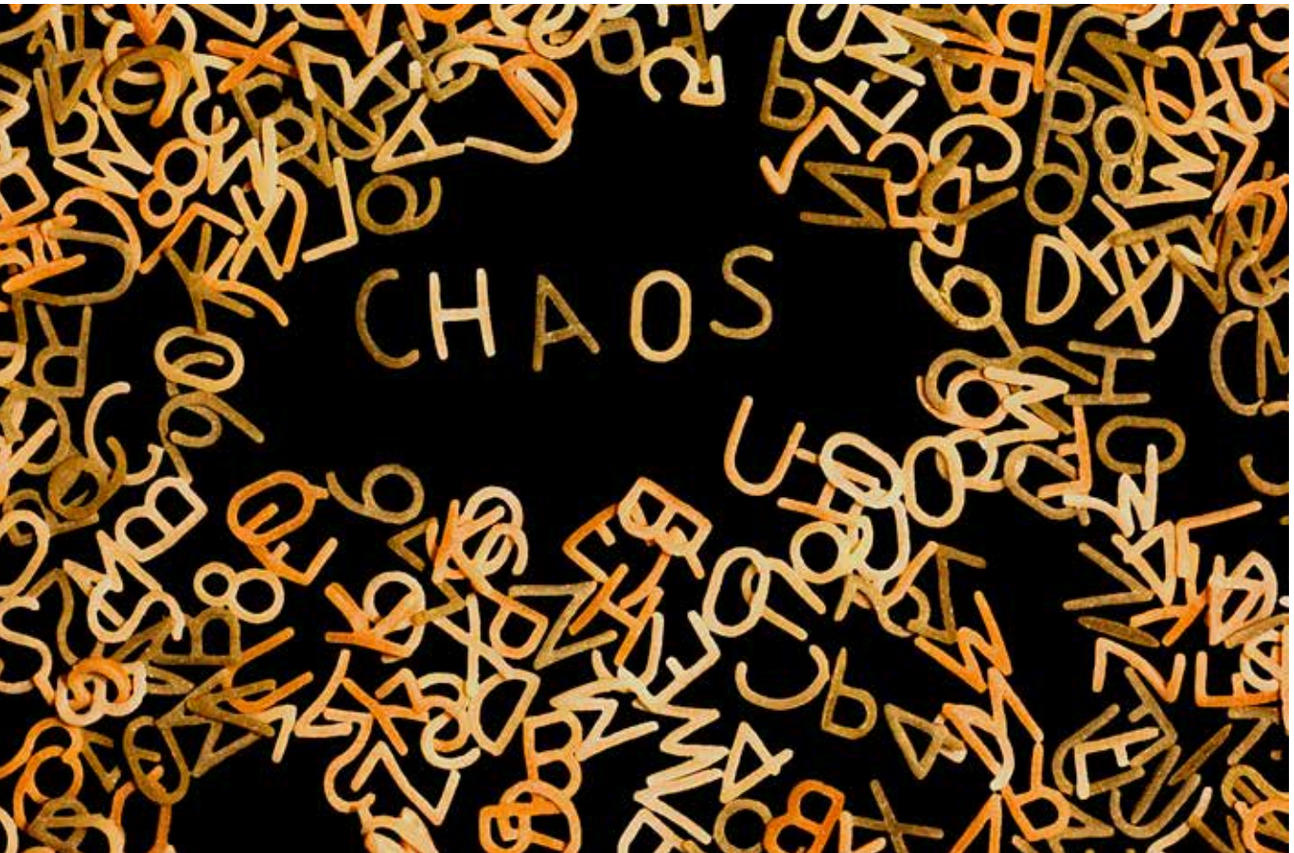
which probably didn't produce the outcome it had hoped for, or the carbon reductions anybody hoped for.

DYALA SABBAGH: Was that partially a result of not having the right information or data?

ROD MACGREGOR: I'd like to echo the earlier point, which is that no one company or entity can solve these very complex problems, and so if you create market conditions which will solve the problem, then you're kind of crowd-sourcing the solution, and that tends to produce better answers.

AUDIENCE MEMBER: I just wanted to follow up on the point of government regulations; what is it that government should actually do? What kinds of frameworks are required to incentivize the private sector to become more active in clean technologies? And how much would you like to see GCC governments cooperate better?

WIM THOMAS: I think governments - like big companies - they learn as they go along and if you have a system that works, it's difficult to proactively change that. So in a sense, you have induced "positive" stress to effect a change. Look at Germany now with renewables coming in. And for food it could be the same.



I think the future is much more complex and will be more integrated, but we can't expect to get it right the first time. Obviously there are vested interests as well to consider.

Regarding subsidies, they would be effective for example if given to technologies that are at the research stage such as what's being done at Masdar. There could be a framework for people to compete for the subsidies and let the best win.

DYALA SABBAGH: Wim - I'd like to ask you to close this session please with some concluding thoughts on the key challenges and priorities ahead.

WIM THOMAS: The rising complexity between the food-energy-water stress nexus definitely needs more thought and more collaboration among all players; industry, institutes and governments.

I think big data and transparency to data connection will be very important not only to assess the problem, but also to have relatively faster feedback, and so better competitiveness.

On current regulation, quite often it hinders new technologies actually being deployed, so introducing greater flexibility for future changes to keep things balanced and equitable will be important.

And lastly, one theme we haven't really discussed is about equity in societies and between societies, which may come to the fore if you get more stress in the food-energy-water nexus; that's certainly something on Shell's radar.

We have to keep asking ourselves if we are on the right track.

> *"If just 1% of the steam used at today's oilfields was produced using solar energy, the reduction in carbon emissions would be larger than the emissions saved from all the electric vehicles ever built."*
>
> **ROD MACGREGOR**