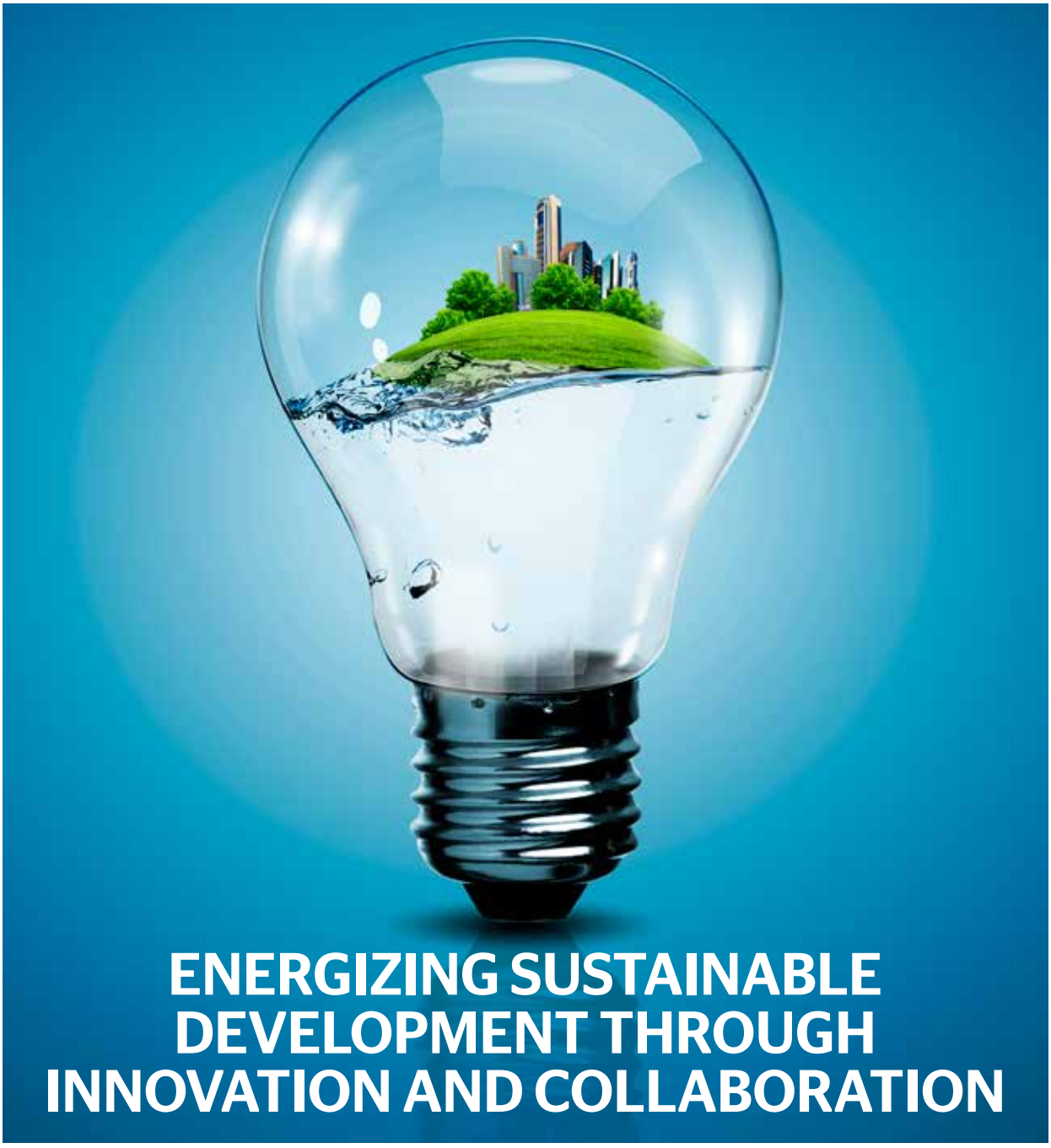

ENERGIZING SUSTAINABLE DEVELOPMENT THROUGH INNOVATION AND COLLABORATION

ADNOC WFES 2014 KNOWLEDGE FORUM

أدنـــوك
ADNOC
شركة بترول ابوظبي الوطنية

A message from ADNOC

WE AT ADNOC are pleased to have organized the ADNOC WFES Knowledge Forum, an event that left its mark at this global foremost energy event.

Our overall participation in the World Future Energy Summit (WFES demonstrated our strong commitment to playing a major role in the field of energy efficiency and clean technologies.

In addition to having our presence felt through the participation of our delegates in the Conference, the Project & Finance Village, the Young Future Energy Leaders program, as well as the corporate meetings and concurrent social events, organizing the ADNOC WFES Knowledge Forum at our stand in the exhibition was an added value to our company's portfolio.

The event was a tremendous value for all participants as it provided an ideal platform for networking and exchange of knowledge.

Abu Dhabi National Oil Company (ADNOC)

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Produced by Gulf Intelligence on behalf of ADNOC

UAE Energy Infrastructure: Integrating New with the Old

By Ali Al Jarwan, CEO, ADMA-OPCO

In recent decades, there has been a major investment drive into various infrastructure elements in the UAE. Today, the country's transport infrastructure, for example, is ranked first in the Middle East and 11th worldwide.

A sustained and joint push by GCC countries towards building out and integrating their transport and energy infrastructure further will produce great benefits. Sitting at the crossroads of old and new trade routes such as the south-south energy corridor, which links Africa, the Middle East and Asia, the UAE and its Gulf neighbors have an opportunity to use their strategic geographic location and advanced infrastructure to capture a growing share of the ensuing trade.

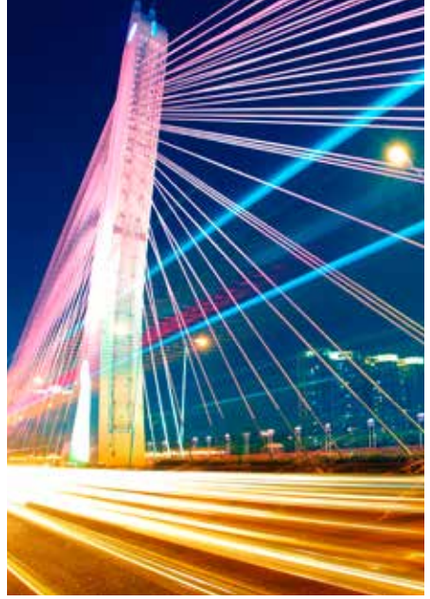
The strategy of ADNOC and its subsidiaries is to move towards greater energy infrastructure integration – in Abu Dhabi and the wider UAE, which we have seen with projects such as IGD (Integrated gas development) and through collaboration on key strategic projects with other domestic players such as Union Railway on the sulphur rail line and with IPIC on the Habshan-Fujairah pipeline, which create economic benefits to the country as a whole and at the same provide a strategic oil supply route to global markets.

The Habshan pipeline is also a project that supports the distribution of the UAE's wealth for on the back of it storage facilities, a refinery and petrochemical units are being built at the port of Fujairah, adding significant economic value for the emirate.

Adnoc recently signed an MoU with Masdar towards exploring and developing commercial-scale projects for carbon capture, usage and storage (CCUS), which represents another step towards greater energy infrastructure integration and greater efficiencies.

Since the Industrial Revolution, energy systems have evolved from smaller single-service systems such as steam engines that supported early mining, transportation and manufacturing into highly integrated ones, such as natural gas and electrical transmission and distribution systems that power homes, industries and businesses.

Abu Dhabi has invested heavily in its transport, trade and energy Infrastructure over the past decade. The infrastructure build-out is part of the emirate's broader strategy to diversify its economy away from hydrocarbons, transform itself into a knowledge economy and ensure sustained long-term economic growth.



At the same time, investments in new projects aimed at closer integration with the UAE's other emirates have accelerated. The integration of domestic energy infrastructure such as the Abu Dhabi-Fujairah crude oil pipeline and the UAE-wide electricity grid have strengthened Abu Dhabi's position as a global energy and trade center. This in turn has fuelled economic growth in the emirate and the UAE as a whole.

The UAE's infrastructure-led approach has been a key driver behind economic integration between GCC states and, by extension, with the global economy. Going forward, integrating energy infrastructure both on a national and a regional level will be seminal to ensure clean, secure and affordable energy for the UAE and other Gulf states.

The interconnection of the GCC electricity grid is one example of a project that has provided benefits to all member states by increasing efficiencies in the regional power sector and reducing investment requirements into new electricity generation capacity. Similarly, the Dolphin pipeline, which transports natural gas from Qatar to the UAE and on to Oman, serves as an example of how cross-border initiatives can create value for all stakeholders.

More cross-border transport projects will be required. Today, there is no longer such a thing as a national market for energy. Gas and electricity will need to be transported over greater distances, which – in this region – will require closer collaboration between Abu Dhabi, GCC governments and, in the future, the region's neighbors.

And, as the share of renewables in the region's energy mix will grow, investments will be needed to build up the production and transport infrastructure capable of accommodating the unpredictability of renewable power generation within local and regional markets.

Beyond physical infrastructure, the emergence of trading platforms such as the DME and the DGCX are tying the UAE, and the region, closer to international markets, notably to Asia, which is the largest consumer of Gulf hydrocarbons.

There is a strong case for greater integration beyond energy infrastructure. Economic integration streamlines the flow of goods, labor, capital, and services within those countries, and puts them into a stronger position vis-à-vis the rest of the world to negotiate trade agreements. Increased intra-GCC trade, investment and development would leave hydrocarbon-exporting GCC states less exposed to global economic conditions and resulting swings in oil prices.

Integrated and efficient energy industry is important for the UAE as it will boost efficiencies at a time of rising domestic and global energy demand, thus integration is also important for energy security.

"The UAE's infrastructure-led approach has been a key driver behind economic integration between GCC states and, by extension, with the global economy. Going forward, integrating energy infrastructure both on a national and a regional level will be seminal to ensure clean, secure and affordable energy for the UAE and other Gulf states.."

INTEGRATING ENERGY INFRASTRUCTURE

Panel Host: Mr. Ali Al Jarwan, CEO, ADMA OPCO
Panel Host: Mr. Ali Hassan Al Marzooqi, SVP ZADCO
Dr. Klaus Langemann, VP, Wintershall Middle East
Mr. Michel Crochon, Executive VP, Strategy & Technology, Schneider Electric
Moderator: Mr. Sean Evers, Managing Partner, Gulf Intelligence

MODERATOR: Where we are going with "UAE Energy Infrastructure" integration in-country and across the region?

ALI AL JARWAN: ADNOC and its group of companies are becoming more integrated into a single integrated oil and gas company because of the changes facing the industry and because of the increased expectations of the government and our shareholders -- to meet a sustained production target of 3.5 million barrels per day (bpd) of oil and to increase natural gas supplies sufficiently to meet soaring domestic demand. So you will see that previously we were working independently, each part busy operating in their own vertical, but now we are closer to each other both offshore and onshore.

The Abu Dhabi government has invested heavily in its transport, trade and energy Infrastructure over the past decade. The infrastructure build-out is also part of the emirate's broader strategy to diversify its economy away from hydrocarbons, transform itself into a knowledge economy and ensure sustained long-term economic growth.

At the same time, investments in new projects aimed at closer integration with the UAE's other emirates have accelerated. The integration of domestic energy infrastructure such as the Abu Dhabi-Fujairah crude oil pipeline and the UAE-wide electricity grid have strengthened Abu Dhabi's position as a global energy and trade center. This in turn has fuelled economic growth in the emirate and the UAE as a whole.

MODERATOR: In the last few months we have seen this integration reach beyond ADNOC to include Abu Dhabi's other national energy companies, what's triggering that greater integration at this time?

ALI AL JARWAN: The National talent in Abu Dhabi is spread across many companies and government agencies and greater integration allows for this competence to be leveraged and be of added-value for all -- sometimes with Masdar, sometimes with ADNOC and sometimes with Mubadala – an integrated collaborative approach will deliver faster solutions.

MODERATOR: The construction of the artificial islands for the development of the Upper Zakum oil field has been one of the most significant investments in energy infrastructure in recent years -- How did you come to this decision?

ALI HASSAN AL MARZOOQI: Upper Zakum is the country's largest oil field. We expect that the ultimate production target will represent almost 27% of total Abu Dhabi production, which amounts to 1 million bpd. The characteristics of the reservoirs being low-energy reservoirs dictated adopting decentralized collection and gathering satellites purposely to partially overcome the system hydraulics impacts. Now after a lapse of 35 years, we need to ramp up production in addition to capturing the upside potential and secure the sustainability.

Upper Zakum was originally developed from almost 100 steel platforms. The original plan was to expand capacity by building more wellhead towers coupled with significant topside facilities expansion.

In parallel, we also assessed Island concept as drilling and production centers considering viability of two major enablers such as shallow water and deployment of extended reach drilling. The result of this assessment by far supported the Island concept due to the following:

- Favorable capital efficiency covering initial investment and life cycle costing.
- Superior differential environmental impact covering mid to long term
- Favorable operation efficiency
- Expandable enabling securing sustainability and capturing upside potential
- Enables extended deployment of secondary recovery, therefore mitigating hydrocarbon gas shortfall
- Enables gradual transition to Islands
- Facilitate future IOR & EOR deployment

I would say within 15-20 years, over 90% of Upper Zakum production will be through the islands.

> *"The integration of domestic energy infrastructure such as the Abu Dhabi-Fujairah crude oil pipeline and the UAE-wide electricity grid have strengthened Abu Dhabi's position as a global energy and trade center. This in turn has fuelled economic growth in the emirate and the UAE as a whole."*
>
> **ALI AL JARWAN**

MODERATOR: Dr. Klaus, as you look at the region from an integrated infrastructure point of view -- where do you think it should go in order to maximize efficiency?

KLAUS LANGEMANN: I think if you consider the Dolphin Project, that's one of very few examples of how integration in the region could work. When you first look at the gas market of the Middle East, it does appear strange that there is so little integrated infrastructure given the scale of demand, with many countries facing a gas deficiency and yet the largest gas field in the world is nearby in Qatar. It does not appear very efficient to export gas shipments to Asia via LNG from Qatar and the UAE on the one hand, and then to have to import LNG in order to meet some of the domestic energy requirements.

There are many examples of demand driving the development of significant energy infrastructure.

I'm from Germany which has almost no natural resources in terms of hydrocarbons and we import most of our gas from Russia through a pipeline system that extends some 5000 kilometers from Western Siberia to Germany. Wintershall is a company that has built the Nordstrom pipeline through the Baltic Sea and is currently with our partner building the South Stream pipeline with the Black Sea -- the cost and benefits of doing that is tremendous because then you have the pipelines directly connected into the market.

MODERATOR: Michel, Schneider Electric operates on a global level, what do you think would be an appropriate roadmap for the Gulf region to adopt to develop an integrated infrastructure?

MICHEL CROCHON: I think the key word is integration. I think technical integration brings a lot because with integration you can extract the most from your Capex investment and minimize your expenses, and by digitizing everything and integrating everything you can make real-time optimization.

Integration is a kind of state of mind willingness. You need a vision to change the landscape and foster collaboration between people because at the end of the day integration is about putting people from different origins and different industries together. And this can only be led by strong vision and leadership because it's changing a process, it's changing the way to assess a solution versus the sole product because the optimum is not exactly the optimum of each parties, the optimum is coming from the integration.

I think here in the MENA region where we see less existing infrastructure, there is the opportunity to lead with new infrastructure and adopt best practice models from everywhere else in the world.

MODERATOR: Ali, what should successful energy integration look like in the UAE and the wider region?

ALI AL JARWAN: The interconnection of the GCC electricity grid is one example of a project that has provided benefits to all member states by increasing efficiencies in the regional power sector and reducing investment requirements into new electricity generation capacity. The strategy of ADNOC and its subsidiaries is now towards greater energy infrastructure integration – in Abu Dhabi and the wider UAE.

The focus is to drive integration with projects such as IGD (Integrated gas development) and through collaboration on key strategic projects with other domestic players such as Union Railway on the sulphur rail line and with IPIC on the Habshan-Fujairah pipeline, which create economic benefits to the country as a whole and at the same time provide a strategic oil supply route to global markets. So in this context ADNOC recently signed an MoU with Masdar towards exploring and developing commercial-scale projects for carbon capture, usage and storage (CCUS), which represents another step towards greater alignment across the new and old energy infrastructure.

MODERATOR: What is the future plan for integrating the Upper Zakum artificial islands into the wider energy infrastructure?

ALI HASSAN AL MARZOOQI: The Upper Zakum field development, which has a target to raise output to 750,000 bpd of oil by 2017 from 585,000 bpd now, is one of the largest and highest profile projects ever to be integrated into Abu Dhabi's energy sector. The plan is to capture upside potential including developing un- and underdeveloped reservoirs to enable ramping up production to a sustainable 1 million bpd.

In addition to the many safety and environmental benefits of the island concept, it provides significant operational efficiencies. Several billion dollars worth of savings in development costs have already been identified for the country. In the long-term, existing steel towers can be disinvested and wells permanently abandoned as they become obsolete. The Islands expected to serve Upper Zakum for more than 100 years.

MODERATOR: Dr. Klaus, coming into the UAE as an international energy company, how would you compare the maturity of the infrastructure here to support the activity of E&P?

KLAUS LANGEMANN: In terms of E&P, the infrastructure in the UAE is excellent as compared to other regions that are currently being explored and produced. There is a very integrated concept for managing the gas flow within the UAE and that's something we very much rely on because then we don't have to worry about redistributing the gas to the various customers.

But for us coming here as a foreign investor into the country, it is not only the energy infrastructure, it's the entire infrastructure -- if you look at the roads, the airports, the ports, the development of the railways, the power distribution -- the entire infrastructure is in my opinion in very, very good shape.

As an E&P company, firstly you look at where the resources are and how to access the resources and which partnerships are available. And then, of course, I would say topic number two, three and four are all related to available infrastructure. All these components inform the risk profile of what any involvement could be, and that's why we have decided to build our regional head office for the Middle East in Abu Dhabi.

MODERATOR: Ali, do you think Abu Dhabi and the UAE should expect to extract a premium from foreign investors because of the maturity of the country's infrastructure?

ALI AL JARWAN: Yes, I think so. You know we have had generally good relationships with the IOCs for 75 years, irrespective of occasional difficulties from here and there, and we also have had excellent partnerships with major manufacturers, contractors and service companies because of many attractive aspects beyond infrastructure, starting with the openness of the UAE culture and the safety, with good legislation and a good legal system.

MODERATOR: How important is an IOC's commitment to the development of the soft infrastructure to their future license to operate, such as developing national talent, investing in R&D and knowledge transfer?

ALI AL JARWAN: I think it's extremely important because this is the overall integration and this needs to happen from a necessity point of view. It is in the common interest of all stakeholders – from ADNOC to IOCs and contractors – to ensure the soft infrastructure develops.

R&D and innovation haven't always played a prominent role on the UAE's domestic agenda. Over the past two decades, the UAE's focus has been on working towards greater economic diversification, using access to cheap energy to build and power world-scale aluminum and steel complexes, and

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>
> **MR. MICHEL CROCHON**

utilizing feedstock such as natural gas to develop large-scale fertilizer and petrochemical industries.

According to the Global Innovation Index 2013 the UAE now ranks top in the Middle East-North Africa region in four pillars – institutions; human capital and research; infrastructure; and business sophistication. Overall, the UAE ranked 38th in the GII, which looked at 142 countries worldwide. This is a tremendous achievement.

MODERATOR: What is your outlook to 2020 and the role of integration?

MICHEL CROCHON: It's all about developing a more sustainable world and this is very important for all of us as citizens of the world, so for 2020 I see a lot more interconnectivity for the common good. We say in our company to drink our own champagne, to apply to ourselves what we advise our customers, so for example we try in our own buildings to save more energy. We all need to do more in our communities, so we promote solutions for power generation off the grid, and in Africa we have projects for bringing light to people or bringing energy to the people in the countryside.

We are not saying to stop development, but decoupling growth and energy usage to make the life of everybody more sustainable.

MODERATOR: Ali, what is your vision for the integration of UAE energy infrastructure in 2020?

ALI AL JARWAN: I think it is really journey. One step at a time.

We have already completed more than 50 years of being a leader in oil and gas jointly with our partners and it has seen continuous improvement. I'll give you an example, ADNOC has been a leader at reducing carbon emissions by reducing gas flaring, for instance; we have achieved 96% utilization of gas and every year we are targeting 10% lower. And for gas, I think by 2020 I would imagine more integration between Oman, the United Emirates and Qatar because the liquid gas market will be more mature at that time and it will be good to explore the opportunities, exporting or importing, as required.

I think we will always see unexpected changes -- the U.S. was prepared for importing gas, and now they are exporting gas because of the shale gas. So things could change very fast!.

> *"As an E&P company, firstly you look at where the resources are and how to access the resources and which partnerships are available. And then, of course, I would say topic number two, three and four are all related to available infrastructure."*
>
> **DR. KLAUS LANGEMANN**

In the Oil Industry, the Case for Clean Technologies is Clear

By Arafat Saleh Al Yafei, Manager CO2 & Nitrogen Development Dept., Reservoir Engineering Division, ADNOC

For oil companies across the globe, the introduction of clean technologies and solutions is no longer an option, it's a must. Faced with an upward-sloping energy demand curve and increasingly tight emission reduction targets, boosting efficiencies and minimizing environmental impact is the name of the game for global energy players today – national oil companies (NOCs) included.

To be sure, for NOCs such as ADNOC, getting the hydrocarbons out of the ground will firmly remain at the core of their business. After all, ADNOC still sits on some of the world's largest oil and gas reserves, and maximizing their exploitation on behalf of the government remains the key objective – to help meet global energy demand and fuel the domestic economy.

But as Abu Dhabi—like other countries in the region— is going to enter its second century of oil and gas development era, conventional extraction methods won't be sufficient to meet these objectives in the longer term. The introduction and application of new processes and technologies aimed at boosting recovery rates and maximizing production will therefore be critical.

This is where clean technologies such as carbon dioxide (CO_2) injection via enhanced oil recovery (EOR) come into play. For Abu Dhabi and other Gulf states, the application of CO_2 EOR on a larger scale provides two obvious advantages. It enhances oil production while liberating natural gas that would be used otherwise for injection into oil fields to boost recovery. This allows meeting both domestic and global oil and gas demands. In addition, it helps limit emissions in a region that has one of the world's largest carbon footprints.

In Abu Dhabi, ADNOC is seeking to utilize CO_2 EOR as part of a joint venture with local partner Masdar through a pioneering carbon capture, usage and storage (CCUS) project that's due to come on stream by 2016. The project may have been some time coming, but the rationale for it is clear: on the one hand, emissions from power, steel and aluminum plants in the emirate are rising; on the other hand, the number of oil fields that require tertiary recovery will grow.

Capturing the CO_2 and injecting it into these fields, and freeing up much needed gas resources in the process, therefore makes sense. Naturally, it's not that simple. Going forward, the challenge will be to make CCUS projects both commercially viable and attractive to invest in. To this end, the joint venture between ADNOC and Masdar will—through the implementation of its first CCUS project sourcing CO_2 from Abu Dhabi's Emirates Steel Industries—create a benchmark for the technical and commercial delivery of CO_2.

Once CO_2 EOR is proved to be feasible in Abu Dhabi fields, the potential CO_2 demand from ADNOC may rise on the back of expanding oil production in the future, and Abu Dhabi will thus create a commercial playing field that will enable other companies, project developers and investors to enter the market on a commercial basis once a pricing for CO_2 has been established. As such, the ADNOC-Masdar CCUS project will truly be a pioneering effort.

Despite the long road to get there, the level of maturity at ADNOC's fields is still relatively low at around 5-10 percent recovery factors in some major fields, ensuring sustainable production plateaus for many years to come, and therefore there wasn't an actual need to pursue CO_2 EOR in the past.

However, with ADNOC seeking to raise oil production to 3.5 million barrels per day by 2020, domestic gas demand growth not letting up and Abu Dhabi efforts sin reducing carbon footprint, it was recognized several years back that implementation of clean technologies such as CO_2 EOR will be integral to meeting these targets – and it was in the this context that the first CO_2 EOR pilot project in Abu Dhabi was launched in 2009.

In addition, numerous studies have been carried out over the past few years with some of our international partners to identify what volumes of CO_2 will be needed at reservoirs in Abu Dhabi over the next five, 10, 15 years to get a better understanding of future demand requirements. The plans are being supported by R&D initiatives that ADNOC has launched in partnership with the Petroleum Institute and whose objective includes carrying out R&D into EOR in coming years.

Other initiatives introducing clean technologies as part of the clean-energy targets laid out in the government's National Vision 2030 are under way within the ADNOC group. For example, ADNOC has introduced solar panels to supply energy for remote platforms needs. Moreover, Abu Dhabi Company for Onshore Oil Operations (ADCO), for example, has committed to introducing 2% of renewable energies into its energy mix by 2025. In addition, ADCO has set an official target to improve energy efficiency in existing facilities by 25% until 2025. According to the International Energy Agency such energy efficiency initiatives will deliver an estimated 65 percent of worldwide carbon cuts in the energy sector by 2050.

Initiatives such as these can go a long way directing hydrocarbon fuels towards where they can add most value: in domestic energy-intensive industries and in global markets faced with long-term energy demand growth. For oil companies such as ADNOC, it will continue to apply cutting edge and proven technologies to ensure sustainability of energy supplies.

"Faced with an upward-sloping energy demand curve and increasingly tight emission reduction targets, boosting efficiencies and minimizing environmental impact is the name of the game for global industrial players today."

CLEAN TECHNOLOGIES

Panel Host: Mr. Arafat Saleh Al Yafei, Manager, CO2 & Nitrogen Development Dept. Reservoir Engineering Division, ADNOC
Mr. Paul Crooks, Project Manager - CCUS, Masdar Clean Energy
Mr. Richard Doidge, MD - Maersk Oil Middle East
Mr. Robin Mills, Manaar Energy Consulting
Moderator: Mr. Oliver Klaus, Gulf Intelligence

MODERATOR: We're here at the ADNOC stand to talk about clean technologies. Why do clean technologies actually matter to ADNOC?

ARAFAT SALEH AL YAFEI: ADNOC has to adopt proven new technologies in its operations. You cannot continue meeting the increasing challenges in field operations with the same classical knowledge. We have to adopt new technologies; new ways of thinking; new processes; clean technologies are presenting one of those options. When we talk about clean technology at ADNOC it's mainly about enhanced oil recovery, which improves our production target but is also reducing carbon emissions within the Emirate of Abu Dhabi. As everybody knows, Abu Dhabi is one of the highest carbon emitters per capita and there is a mandate by the government to represent Abu Dhabi as a pioneer in environment preservation and protection. ADNOC is complying with that direction through application of EOR. So we're meeting the objective of producing more oil; but on the other hand, we're making it more efficient in terms of less carbon emissions.

MODERATOR: Where does the ADNOC-Masdar joint venture on carbon capture utilization and storage fit into the broader strategy?

ARAFAT SALEH AL YAFEI: An oil company has different options for oil recovery. They can vary from hydrocarbon gases to non-hydrocarbon gases to chemicals and microbial. In our case, we are going for the most proven technology which is CO2-EOR. In Abu Dhabi, we have different sources of CO2 such as emissions from power, steel and aluminum plants. There is a portfolio of available CO2 sources and we have a ranking of options of which we select the ones that are best for us – technically, commercially and strategically. This is why we're looking at clean technologies.

MODERATOR: Paul, heading up the Masdar-ADNOC joint venture, could you give us a brief update on where you stand and also what the main challenges are implementing it?

PAUL CROOKS: The project was announced back in July last year. We have a 30-month timeframe and are expecting to be able to produce carbon dioxide to deliver to the Rumaitha and Bab fields by January 2016, where ADCO is already putting in place facilities to do the injection of the CO2 for enhanced oil recovery. The challenges that have always been in the CO2 environment are to get to a commercially viable CO2 cost. This is where the joint venture between Masdar and ADNOC has been quite brave in actually coming together to try and establish both a technical and a commercial playing field that establishes how CO2 will be technically and commercially delivered from sources, which could be from inside the ADNOC group but also from power stations etc. It all depends on demand for CO2 from ADNOC. As more CO2 is demanded from ADNOC for

increasing oil production, it will open up the avenue for other sources of CO2 to go into the commercial playing field. Now, with the commercial playing field, if it's on a level that everybody understands, we will have a much easier entry point for other companies to come in because they know it's bankable.

MODERATOR: Maersk is a provider of clean power solutions. Are you optimistic that 2016 is the year where Maersk is going to become heavily involved in CO2-EOR?

RICHARD DOIDGE: We see our TriGen technology as one of the potential solutions that could be interesting for Abu Dhabi. We brought this into the company as a capability that we perceived would be necessary for us with maturing assets of our own eventually requiring a source of reliable and cost-effective CO2. The reason that we were interested in this is because TriGen has a number of different revenue streams, one of the most important being the power that it generates at a single TriGen unit as a power station would generate net around 150-180 megawatts of electricity. Then, of course, there are revenues from the water. And furthermore, in order to get the oxygen to power this thing, you need an air separation unit so there are potential revenues from the nitrogen that is a byproduct of producing the oxygen. The result is, in most cases, very competitively priced CO2. We thought that was interesting from our own economics. We also think it's interesting from an upstream business development perspective where we see opportunities to actually deploy this capability of TriGen technology and deploying that to access upstream opportunities in other parts of the world. There's a demonstration plant running in Bakersfield, California. What we're working on in a number of countries, in the U.S., in Southeast Asia, and are also discussing here in the Middle East, is actually launching our first commercial project involving TriGen.

MODERATOR: We haven't seen many CCS projects around the world. What's required to make these technologies take off in a much bigger way?

ROBIN MILLS: If you look around the world, I see three main reasons why CCS is really not taking off. The first and the biggest reason is simply there's not a global price on carbon. Of course, if you're able to produce power from coal, oil or gas and just emit your CO2 to the atmosphere with no price, you'll do that until there is either a price or a regulation that you have to capture CO2. If you look at, for example, solar power in Germany, that's been driven by subsidies so that people are going to do solar power. The second reason is that CCS projects are just quite complicated. The technology is quite well understood, but they're commercially complicated because you're putting together a utility or an industry that is used to running to high levels of efficiency, stability and reliability, and is not used to dealing with sub-surface risks and reservoirs, and all the complexities of that part of the chain. Then on the other end of the line, you got an oil company that's used to producing oil and is not used to running a utility with a very different business model, with much lower margins and a much lower risk profile. Getting those two entities to work together is quite a difficult one. The third reason is that CCS projects require someone to write a big check. You talk about a billion dollars or something. Of course, there are a lot of small demo CCS projects and we learn a lot from them, but they don't tell you enough about the technology when you scale it up; they don't tell you commercially how it works; and they don't tell you what economies of scale you can realize.

"In Abu Dhabi, we have different sources of CO2 such as emissions from power, steel and aluminum plants. There is a portfolio of available CO2 sources and we have a ranking of options of which we select the ones that are best for us – technically, commercially and strategically. This is why we're looking at clean technologies. "

ARAFAT SALEH AL YAFEI

MODERATOR: How important is it that there is commitment by the government to pursue these kinds of projects and to be prepared to make an upfront investment to show it's doable and feasible?

ARAFAT SALEH AL YAFEI: I think a new business always requires a tough decision at the beginning. However, the way we work together as a team together with ADCO and Masdar is we wanted to introduce a self-sufficient CO2 project that can be commercially sustainable for many years. That's why we were slow in our approach, but it was for a good reason. Today, if you talk with officials from the IEA, for example, they always mention CO2-EOR. Two years ago, nobody was mentioning EOR. Everybody has realized that for those CO2 projects to be alive, you have to come up with a revenue stream, which comes from EOR. Now, to clarify that, an EOR scheme contains CCS. You will store portions of the injected CO2, let's say 30-40 percent of whatever you inject, permanently in the reservoir. So in a way we are increasing production; but also, we are using a way of sequestrating CO2 partially in the reservoir. And it will help us for the time being to learn more about the technology, and with time we may improve and apply it to different areas where they can add value.

MODERATOR: Richard, the role of government in this – are you satisfied with the progress that's being made on this front?

RICHARD DOIDGE: The answer is: it depends. Where CO2 EOR is not so mature and if you have an environment where there is a national oil company and there's an overall perspective on whether this is a risky thing to do or a beneficial thing to do, then clearly, you need the support at government level. You need entities, individuals, to be able to take a higher look at what's going on and join up the dots of the individual components and say: what does this actually mean from the perspective of the national benefit? And I think that here, and in many other countries where there is enormous potential, it's something that's needed and then has to translate into support for enabling the business.

MODERATOR: Robin, how did the U.S. and Canada make these projects a success?

ROBIN MILLS: The approach in the U.S. and Canada was very much: it was an opportunity. In the U.S., it was driven initially by natural CO2 sources, underground CO2 fields that were discovered by accident. Then people saw the EOR opportunity. There are a couple of things in the U.S.: firstly, there were a lot of oil companies with very mature fields that were looking what to do with these fields? That's the real commercial drive to use CO2. And particularly from the early 2000s when oil prices were rising, you got EOR specialists like Denbury, who decided that's what they're going to focus on. On the other hand, you had—you can almost say—a visionary project,

which was a very long CO2 pipeline from Colorado down to West Texas to bring CO2 to those fields. That was really the anchor for future CO2 developments in that region, because you had a very long and expensive pipeline; but that meant people could get CO2 at a competitive cost and from that, you could start doing branches and tying in different fields. That shows that setting the early infrastructure is very important and that once you get over that barrier, it's a lot easier to do new projects once you have that infrastructure and once the costs are coming down.

MODERATOR: Would there be a case for a CO2 pipeline grid connecting the Gulf States?

PAUL CROOKS: Part of the preliminary work that was done by Masdar was to look not only at this one project that we're doing with ADNOC now, but at a nationwide or an Abu Dhabi-wide pipeline network. The infrastructure is critical. If it's in place, you can connect the sources of the CO2 with the users, ultimately ADNOC. That's why Abu Dhabi is uniquely placed, because the sources and the injection point are very close to each other, so the cost of transportation are kept down. If you have a pipeline operator who is delivering and transporting CO2, you can have multiple sources and multiple syncs in your transport. That's where we're heading with this ADNOC JV, to actually start the beginnings of that infrastructure to be able to look at multiple sources. So once we get past the ESI project, there's potential to go to other places within the ADNOC group, to power stations, and that opens up the whole avenue for Masdar.

MODERATOR: What's being done to address achieving greater energy efficiencies, for example, in a company like ADNOC?

ARAFAT SALEH AL YAFEI: The objective of ADNOC is to support the economy of Abu Dhabi. An easy available option is energy efficiency improvement. As an example, ADCO has set an official target improving energy efficiency in existing facilities by 25 percent up to 2025. They also set an official target of introducing 2 percent of renewable energies in their energy mix in ADCO by 2025. So this is an obvious commitment by ADCO, for example, within ADNOC group, and we have similar things in remote platforms using solar panels. We'd like to get to these energy efficiency targets through renewables so we can direct the hydrocarbon fuels towards where they can add more value: energy-intensive industries, for example.

MODERATOR: From Masdar's perspective, what else is being looked at?

PAUL CROOKS: Masdar's mandate includes the whole energy efficiency mix. It's looking at both solar and wind. But there's also quite a lot of work, a lot of research being done within Masdar Institute, which is about energy use and how we can efficiently use the energy that we have available, not only here but around the world. Masdar Capital looks at investing in companies that have a clean energy mix to promote those companies, not only from a global perspective, but also to bring those technologies back here to the UAE. So Masdar is looking at it in terms of it's the catalyst; it's the company that's actually generating the direction of energy efficiency, both here in the UAE and globally to get those investments back in and to actually become a part of the way we do our business. Then Masdar Institute takes that further by doing the research in all those areas.

MODERATOR: In terms of the region being open to looking at cleaner technologies, looking at greater energy efficiencies, would you say in recent years there has been a mentality change and is this being looked at across the region in more earnest?

ROBIN MILLS: I think very definitely over the past six, seven years, there has been a very big change in the region's mindset. And I think the awareness of the need for clean technology has come up a huge amount. If you go back seven, eight years, it was almost never mentioned. Now you see it all the time and the media cover it extensively. You see a lot of real projects and real initiatives. And I think Masdar has a lot of the credit for that in terms of being a very large and very visible commitment to clean energy which helped set a bit of a standard that other countries then woke up to and had to follow. There are environmental drivers, sure. The countries here are looking to improve their environmental performance and cut CO2 footprint. But I think also critically, there have been very important economic drivers, and many countries in this region are struggling with gas shortages, struggling to keep power generation growing fast enough to keep up with demand.

MODERATOR: One factor in the equation is subsidies, which if you address these could very

swiftly change the equation, probably in favor of cleaner technologies – do you think this is going to happen anytime soon?

ROBIN MILLS: I think it will come. In the past few years, Bahrain has increased gas prices. Oman is increasing gas prices. Dubai has increased its electricity and water prices. All countries in the region will follow sooner or later. The question is how do you do that sensitively so that you don't have too much impact on the economy and on energy-intensive industrial sectors and on consumers? It's a process that takes time and understanding. If you want to drive real deep improvements in energy efficiency across the whole country and across the whole region, the prices have to come up to something more like international market levels. And I think, yes, we are seeing that. The other side that's very important for clean energy is that prices are transparent so that you know if you generate a unit of electricity, you're going to get a certain price for it, and that's a price that everybody can see. If there's a green subsidy, then that's also explicit. And if I generate clean power, whether I'm a solar power developer or a CCS developer or a wind farm, I know I'm going to get my credit for my clean energy above the normal price. That still has to come, I think, rather than having ad hoc support. For the first few projects, okay, you have a one-off support to get a project going. But obviously, if we're doing tens and even hundreds of clean energy projects in the region in the future, there has to be a consistent scheme.

RICHARD DOIDGE: Subsidies are obviously a very sensitive issue. Our general approach is that we try to build a compelling commercial business proposition for an opportunity that does not rely on certain subsidies being removed—I'm talking about subsidies on fossil fuel-generated power; nor does it rely on new subsidies for clean power—and just accept that we have to maneuver within the prevailing space in terms of prices, subsidies, etc. Having said that, Robin is absolutely right: transparency is what's needed, so that you know as a business developer, a project developer, if you're going to come along with a proposal that is based on such and such a power price and such and such a CO2 price that you actually have a viable business proposition that's commercially making sense to you and to your counterparties.

"Transparency is what's needed, so that you know as a business developer, a project developer, if you're going to come along with a proposal that is based on such and such a power price and such and such a CO2 price that you actually have a viable business proposition that's commercially making sense to you and to your counterparties."

RICHARD DOIDGE

Maximizing In-Country Value to Build a Sustainable and Diversified Economy

By Mubarak Al Mehairbi, Manager,
HR Planning & Recruitment, ADNOC

Building and maximizing in-country value is an essential element in the quest towards economic sustainability and diversification.

As a key contributor to Abu Dhabi's economy, the oil and gas sector—which in 2012 accounted for more than 56 percent of the emirate's gross domestic product (GDP)—is integral to driving the creation of in-country value through the transfer of knowledge and technology, investing in research and education, and the establishment of best practices across the industry.

ADNOC sits at the heart of this strategy. Today, ADNOC—together with the wider energy sector—already provides fundamental support in deepening and broadening the domestic industrial base, and driving the country's broader socio-economic development.

Large-scale downstream initiatives such as Chemaweyaat, in which ADNOC holds a 20-percent stake and which in December entered a multi-billion dollar deal to build a petrochemicals complex with Bangkok-based Indorama Ventures in Abu Dhabi, are a case in point. Other downstream projects in the areas of storage, trading, shipping and specialty chemicals also serve as examples of the added value the energy sector can provide to the local economy.

These kinds of projects help create jobs and develop new skill sets among the local population, while at the same establishing key infrastructure of benefit to the wider economy. More needs to be done, however, in particular in terms of developing the national workforce.

ADNOC, as the national oil company of Abu Dhabi, has an important role to play in this. The emirate's population is young and growing, and requires jobs. At the same time, the requirements for technical experts in the emirate are increasing as the era of easy oil is coming to an end and the extraction of existing and new hydrocarbon reserves becomes more complex and technically challenging.

The need to create jobs on the one hand and to develop a national workforce with the right skills set for the oil industry on the other was recognized as early as 1999, when ADNOC established its national recruitment division as part of the government's newly-introduced Emiratization efforts. Charged with addressing the issue both from the supply and the demand side of the labor market, the division embarked on a program that targets an ambitious 75 percent Emiratization quota in the ADNOC group of companies by 2017.

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The goal of ADNOC's Emiratization strategy was always to develop a growing numbers of Emiratis with the technical capabilities needed inside the company. To this end, ADNOC got involved with Abu Dhabi's Petroleum Institute, which develops high-quality engineering and science professionals—including since 2006, females—and established the ADNOC Technical Institute (ATI), a vocational training institute that trains U.A.E. nationals as technicians. Technical Career Progression programs, aimed at grooming and retaining internal technical specialists and experts, have been introduced.

These initiatives were complemented by feeder institutions such as The Glenelg School of Abu Dhabi, which ADNOC founded in 2008, as well as the ADNOC Achievers Oasis, which sponsors high-performance sciences students in junior and high schools. In addition, the ADNOC Scholarship program offers talented high-school graduates the opportunity to pursue their university studies in leading academic institutions in the U.A.E. and abroad.

There is a clear rationale behind ADNOC getting involved in the young generation's education at an early stage. To ensure a steady flow of local talent into the industry, one needs to stimulate and sustain children's interest in sciences to attract them into science-related studies and, later on, into careers as engineers or researchers at the ADNOC group of companies. At the same time, it needs to be ensured that education standards are of high standard and meet industry requirements.

Therefore, such initiatives are important. Over the past 40 years, ADNOC, largely drew on the expertise of its international industry partners on meeting the technical requirements in the domestic oil and gas sector. The company's Emiratization efforts, however, have led to a steady increase of Emirati talent entering the oil and gas industry via ADNOC's recruitment division, thus building up local technical capabilities.

The efforts haven't stopped there. Major contracts signed in recent years with international oil companies (IOCs) call for training and personnel development of Emiratis, and support in the research and development (R&D) sphere. To this end, ExxonMobil, for example, agreed to support the establishment of a specialized R&D facility at the Petroleum Institute when it signed an agreement with Zakum Development Company (ZADCO) giving it a 28 percent share in the Upper Zakum field development.

The focus on R&D is a key priority for ADNOC and several R&D centers have been launched, including at Abu Dhabi Oil Refining Company (TAKREER), which is seeking to become a leading research center in the field of refining technology, process and product development. In an increasingly globalized world, a country's competitive edge and ability to attract foreign investment will largely be determined by its ability to gain competitive advantages through innovations. This makes the investment into R&D so important.

But to carry out successful R&D one needs researchers. And to build a sustainable R&D environment that benefits the country as a whole, one needs to develop and utilize local talent. As such, ADNOC is seeking closer collaboration with academia and support from the government in order to develop a long-term strategy that supports these ambitions.

MAXIMIZE IN-COUNTRY VALUE

Panel Host: Mr. Mubarak Al Mehairbi, Manager, HR Planning & Recruitment, ADNOC
Mr. Rafi Baghdjian, COO, Shell
Mr. James McCallum, CEO & Chairman, LR Senergy Group
Ms. Clare Woodcraft-Scott, CEO, Emirates Foundation
Moderator: Ms. Dyala Sabbagh, Partner, Gulf Intelligence

MUBARAK AL MEHAIRBI: To bolster in-country value, at ADNOC we have established a committee which targets to achieve 75% Emiratization by 2017. Due to the shortage of national technical talent, we set up the Petroleum Institute in 2002, and the ADNOC Technical Institute after that, as well as the ADNOC Achievers program to support young Emiratis in the sciences.

MODERATOR: Clare - how much of a challenge is this issue of skills development for the next generation?

CLARE WOODCRAFT-SCOTT: For the last two years, Emirates Foundation has focused purely on youth development. We had a more varied portfolio in the past, but we firmly believe that developing local talent is critical to long-term, successful socioeconomic development in any country.
We're trying to guide and inspire young people, and one of the biggest challenges for young individuals, Emiratis and non-Emiratis, is simply to understand what the future employment opportunities of the country are and how to access the private sector. For example, you have some amazing initiatives coming out of the aerospace sector here, companies like Strata, and a lot of downstream industries also coming from the oil and gas sector that people just aren't aware of.
There's a very low percentage of participation of Emiratis in the private sector, so bridging that gap is crucial, and what we offer are programs like "Think Science" which is an annual platform that brings young people who are studying the STEM skills (science, technology, engineering, and mathematics) together with the business sector.

MODERATOR: Rafi - what about on the job training at Shell?

RAFI BAGHDJIAN: Here in Abu Dhabi, with ADNOC and Gasco, we have a good number of engineers, Emiratis, who've done a few years already in their companies and then are placed in Shell, abroad to really develop themselves, to work in an international environment.

JAMES MCCALLUM: I'd like to add something here. The population of Emiratis within the UAE is in and of itself very different to other hydrocarbon economies in the world , we are dealing with very much smaller numbers across the skills levels than say Saudi Arabia. We need to be very clear what we're actually trying to achieve. I think that as Mubarak said, focusing in on the high-end, high-value opportunities is important and the advent of the Petroleum Institute was a fabulous step forward in that regard.
But ultimately, in my opinion, universities function at their best when they form key knowledge partnerships with industry. The international reach of such relationships is absolutely critical. If one is to develop young talent to be really useful and fulfilled in the long-term, you don't develop it in a limited geographical location. Young Emiratis need to be given the opportunity as a part of such partnerships to develop and hone their skills in the international operating arena, and that's yet to really happen in a big way.

MUBARAK AL MEHAIRBI: I agree - we now have more than 1,000 scholarships internationally, as well as the conversion program, and we are signing memos with our partners just to reduce the risk of having a lack of talent in the future.

MODERATOR: What about solving this issue by bringing the external knowledge in, through joint ventures, such as for example the Bab sour gas field project between ADNOC and Shell.

JAMES MCCALLUM: Perhaps but another methodology that's frequently very successful is where you look to companies to actually help in bringing in visiting professors and distinguished lecturers. For example, as well as being Senergy CEO, I'm also a visiting professor of Energy at Strathclyde University and simply as a consequence of that Senergy/ Strathclyde relationship we have together developed a whole Project Management course which has since been added to the syllabus. Now in its third year it is producing professional engineers with a project management expertise, who then disperse all over the world.

MODERATOR: I'd like us to explore how the oil and gas sector - which accounts for 56% of GDP in the UAE - can help broaden economic diversification. What industrial growth can it help trigger for example in the manufacturing, downstream and health sectors, and thereby create more avenues for sustainable employment.

JAMES MCCALLUM: The oil and gas industry here in the Middle East is entering a very interesting phase that's potentially critical to this development. We're moving into much more challenging Field Development and Optimization project environment and what comes with that is a real need for best practice. There's an opportunity to build a regional Centre of Excellence in development of this post-easy oil reality because it's a major value driver to ADNOC, to ADMA, to ADCO, to all of the companies in the region here to develop such competency in-country.
As one drives into the area of best practice in execution you begin to bring in the best technology and in time with that you seek to create a local equipment manufacturing sector to support the knowledge in the region. This is the critical step that builds sustainability into the economy, with new technology, new patents, new ideas which are anchored in the region.

MODERATOR: Yes - given that there are certain indigenous industries here in the UAE, why haven't we seen more centers of excellence spring up? Take desalination for example - that's huge here.

CLARE WOODCRAFT-SCOTT: I think it's about competitive advantage at the end of the day; you've got to look at core assets and there are some obvious, robust ones here. Clearly, hydrocarbons under the ground is one of them, but also re-exports, logistics, sunshine, hospitality - all great opportunities.

JAMES MCCALLUM: You're diversifying us away from the energy sector and I applaud that, but I'm going to pull it right back to the oil and gas sector. There is nothing stopping the UAE becoming the world center in enhanced oil recovery. It's an agenda which

is increasingly becoming very relevant to the companies who operate here. If you focus in on one or two areas that can make a pivotal difference for the energy industry here in the region you can become the best at it, but it requires dedication, it requires devotion and it requires investment.

CLARE WOODCRAFT-SCOTT: If you just look at where we are sitting here today - at the World Future Energy Summit - this is an indication of what's happening in the UAE more broadly. The WFES used to be more focused on oil and gas, but today it increasingly seems to be about sustainability; it's about looking much more broadly at how the energy sector can drive better diversification and long-term sustainable growth. So, I think the UAE's well placed to drive that discussion.

MODERATOR: Rafi - your thoughts on widening the economic base and using the core oil and gas industry to do that?

RAFI BAGHDJIAN: If you look at Oman, they found that they needed to develop small and medium enterprises from the industry, to serve the industry. Here, ADCO's, ADMA's, and Gasco's contracts and procurement department have billions of dollars of contracts, but most of it goes abroad.
It is possible to start creating small and medium sized enterprises, 10 people, 20 people, to service the industry and maintain certain things within the country; we have helped do that in Oman and Qatar and other places.

CLARE WOODCRAFT-SCOTT: I mentioned the example earlier of Strata, which demonstrates that the UAE is likely to have a very thriving aeronautical industry; 80% of the shop floor there are young Emirati women in manufacturing, producing components, mostly for export, and that's an amazing example of an industry that is undoubtedly connected to energy, but it is also a diversification.
Our challenge in terms of getting young people into these businesses, particularly young Emiratis, is mismatched skills and expectations on both sides. There needs to be a national, even global campaign to help young people understand that in this 21st century where it's much harder to get a job, that you need to have a skill set that is relevant and marketable.
In the UAE, that means predominantly becoming an engineer, but there are many jobs outside of this key sector, such as hospitality which is growing and highly competitive.

MODERATOR: What about investment in R&D and developing an indigenous knowledge capacity?

CLARE WOODCRAFT-SCOTT: I would say one of the critical, developmental challenges of the entire region is the lack of R&D and the lack of connection between academia and industry; I think that's what we need in the region and it will be a very powerful way of helping get the right talent.

RAFI BAGHDJIAN: There is some embryonic R&D relevant to the UAE starting already at Petroleum Institute. The next step is to do more beyond the country.

MUBARAK AL MEHAIRBI: We have a few R&D centers, but our main issue is having enough researchers, so we need to focus with academia and with government support, to develop research centers as a long-term strategy.

JAMES MCCALLUM: You know, Mubarak, there's one area where I think the region here has a real opportunity to take a leadership position. We often face a problem when for example if we are doing an integrated development study for a client, and we nominate a very young person as part of the team, frequently we are asked to replace that person with someone with more experience, usually for cost-based reasons. In our view, it's the wrong decision to make. Whereas if it was made an actual requirement of the tender process to include at least one or two young engineers or geoscientists it would be a great way of developing young UAE talent.

"If you focus in on one or two areas that can make a pivotal difference for the energy industry here in the region you can become the best at it, but it requires dedication, it requires devotion and it requires investment."

JAMES MCCALLUM

MODERATOR: So setting specific employment profile quotas for contracts.

MUBARAK AL MEHAIRBI: This is what we are doing at ADNOC - setting quotas in the mega project contracts where we specify the number of Emiratis that we need to be included in the project.

MODERATOR: Rafi, do see a level of support for this policy?

RAFI BAGHDJIAN: On the large contracts that we have, the cost is irrelevant because we can take a large number. Perhaps on very small contracts I think that's more challenging.

CLARE WOODCRAFT-SCOTT: Employing young talent is a cost, but should be seen as an investment.
There are also challenges around retention and more research is needed around why young people leave jobs so quickly. Often, we find it's because they find that their operational environment is culturally alien to them, that they don't have proper mentoring or support inside the company. Companies need to see that the return on a longer-term investment by an engaged and integrated young Emirati is actually more powerful than taking on non-local talent.

AUDIENCE MEMBER: I have a question on the role of government. It seems to me on the one hand that the government is pushing Emiratization, and on the other incentivizing a lot of the young people to work for the public sector by raising salaries. Is there a conflict there?

MODERATOR: Clare, do you want to take this one? A public/private sector battle on recruitment?

CLARE WOODCRAFT-SCOTT: I can only speak on behalf of Emirates Foundation. Yes, there is a challenge, but it's not just about the financial incentives, it's also about cultural trends. Most young people have family or friends that have all worked for government so they're very comfortable inside a government entity. I think multinationals also need to be looking at how they can render their workspace more relevant - that young nationals are perceived as a value addition and are invested in.

MODERATOR: What about infrastructure in the UAE as a strong harbor for in-country value?

JAMES MCCALLUM: The infrastructure is fantastic to support the export of technology and capability to the other parts of the energy economy, whether that's East Africa, India or of course onshore and offshore in terms of the major energy fields that sit northwards of the UAE. We already have the world's leading Port Authority and the world's most successful airline headquartered in the UAE.
What we need to also have is all the major elements of the energy supply chain. There are many customers, or if you like IOC partners based here already. We need exactly the same in terms of the international service sector companies being based here - if we can encourage them to start developing research centers, build big manufacturing bases, then that locally manufactured technology becomes a major leverage for exporting across a very wide region. We are then in a great position to achieve a really strong employment base within the country.

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