GULF INTELLIGENCE

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Energy Outlook

Doha as R&D Hub: Next Steps?

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Qatar's Ambitious Quest to Build an Energy R&D Hub

TECHNOLOGICAL ADVANCES HAVE always been at the heart of the global energy industry, allowing it to open up new frontiers in the quest for undiscovered hydrocarbon resources and boosting efficiencies in their recovery.

Experimental hydraulic fracturing, which was first used to extract natural gas from limestone in the U.S. in 1947, is a case in point. It may have taken decades, but ongoing advances in the technology, also known as 'fracking', have allowed the tapping of oil and gas reserves that otherwise would have been uneconomical to develop, potentially opening up billions of barrels of oil and cubic feet of gas for extraction and production in the U.S., and around the globe.

Driving this kind of innovation and building an energy R&D hub with global reach sits at the core of Qatar's national strategy. No doubt, it's an ambitious goal. But then so were the plans that Doha devised in the 1990s as it sought to maximize its most valuable resource, the North Field. Today, Qatar is the world's top LNG exporter and an energy hub in its own right.

There's no shortage of challenges that need tackling. Whether it's addressing environmental issues, advancing alternative and renewable energies or boosting efficiencies in conventional oil and gas – driving innovation by investing in R&D will be fundamental. And Qatar may well play a bigger a role in it.

Sean Evers
Managing Partner, Gulf Intelligence

Qatar National Research Strategy – Energy & Environment Pillar

Faisal Al-Suwaidi, President of Research and Development at Qatar Foundation for Education, Science and Community Development (QF)

Sean Evers (SE):
The needs of Qatar are the guide to where the country's research should go, where the focus should be. How do you align that with the 2030 vision and where do you see—particularly from the energy industry point of view—the needs of Qatar aligned with reaching the 2030 vision?

Faisal Al-Suwaidi:
Qatar's national vision targets sustainable development to improve the quality of life, for example, of the Qatari citizen. It is defined under four pillars: human, environmental, economic and social development. If I look at the 72 objectives we identified for our research agenda, all of them map out to those four pillars. By addressing those, we will contribute to the sustainable development and also to the standard of living in Qatar.

> "My message to the people who are involved in energy is: research in energy, and specifically in oil and gas, is very much underrepresented in the Qatar Research Survey.

SE:
Can you just drill down a little bit into the Qatar National Research Strategy (QNRS), obviously there are four or five different verticals of which energy is only one. What is the key take-away that people should see in that?

Faisal Al-Suwaidi:
I don't identify or set the priorities for the research community -- they themselves should do it. I think we need to accept that different institutions will do different research for different reasons. But if you are to get funded from the 2.8% His Highness has placed for research, then you need to address my agenda. Yesterday we talked about the contribution of oil and gas in the economy equaling up to 60%. I think this is not surprising to many of us here.

But if I look at the contribution of the energy and the strategy in research and development, it's way below 60%. So my message to the people who are involved in energy is: research in energy, and specifically in oil and gas, is very much underrepresented in the Qatar Research Survey. Like I said, it's not my job to set the priority; it's my job to provide opportunity for people to make and fund and review and evaluate. These are my main responsibilities.

SE:
So in terms of your main responsibilities as a facilitator, where do you see your units coming into play, how do you see their function in implementing this strategy? And is it different than what industry should do?

Faisal Al-Suwaidi:
No. I think it is research in different areas that meets the national agenda. I agreed on 72 research agendas. So people are free to pick up the area that they want to undertake research in. And if you do that, you get funded through Qatar Foundation from the 2.8%. The same thing happened with our institute. We picked up 12 or 15 objectives for the institute that belonged to Qatar Foundation.

SE:
So in some ways, you're a facilitator and a participant?

Faisal Al-Suwaidi:
Yes. But this is through the national institutes that belong to Qatar Foundation. These three institutes will be directly funded from Qatar Foundation. We will manage the national research agenda, we will do some research. But we expect other people to do research too. And if they address our national agenda they get funded; if they do something else, they won't.

SE:
In talking about the research institute in the context that we're here—we're talking about the Qatar Environment & Energy Research Institute (QEERI) —should the industry see that institute as a partner or another silo doing their own research? Will they have a specifically narrow mandate?

Faisal Al-Suwaidi:
Like I said, our starting point is the pool of 72 research objectives that we identified from our research. We agreed on a certain number of objectives that they need to undertake for the next five years as part of their business here. So for them the 72 is narrowed to, I think, 12 or 15 objectives.

SE:
In terms of Qatar Science & Technology Park (QSTP), what's your vision for that in terms of 'its part of this puzzle'? Are they simply a facilitator for both, or will they be a participant?

Faisal Al-Suwaidi:
With the establishment of the research group within Qatar Foundation, we went back to the drawing board and redefined some of the roles for our entities so they will need to read the national agenda to identify what they need to worry about for the next five years. The same thing happened within QSTP. We redefined their responsibility. Now they will do less research and more integration and technology development. This is their role from now on and in order to improve on that, we are changing the board; we're bringing in international members to draw on their expertise. So QSTP will do less research and instead will do more integration and technology development.

SE:
In terms of the Qatar National Research Strategy (QNRS), you're coming up to your first anniversary, your first review – so is it a living document now?

Faisal Al-Suwaidi:
At the workshop last year, I promised two things. One is that this year, QNRS will be a living document; living meaning that this will get reviewed at least once a year and we will organize many things for people to have the opportunity to do that. Second is that we will not micromanage the enterprise; we will not do it at micro level, i.e., we will not dictate what the different institutes will do. So now we're planning the next session and we will do this differently this year. Last year, we did it in two stages: one-on-one interviews, then the workshop.

This year, we'll do it in three stages. First is the one-on-one interview; secondly, we will have a separate workshop for each of the pillars in the strategy, and then we will do the forum or the workshop. What we will do for the objective is that we will go for grand challenges. Now we have a pool of 72. After consultation with a number of the major stakeholders, I think what we want to do is identify the major six, seven, eight or 10 grand challenges that face the country for the next five, 10 or 15 years.

SE:
What is your advice to the energy companies with research centers in QSTP in terms of 'how we can maximize the value of both the

research and, indeed, our broader presence there for the State of Qatar'?

Faisal Al-Suwaidi:
If I look at the strategy of energy, oil and gas companies, our objectives are under-represented. The IOCs with their vast experience should play a vital role in this. There is a big carbon capture project with QSTP, QP and Imperial College. There is one project we started that's well underway.

Now what is next? I cannot understand how energy can contribute 60% of the economy and only have one challenge. I know carbon is a big challenge but there are others. We just need to bring together academia and other players to identify what the next challenges are. Shell and ExxonMobil are in the driver's seat because they are the two biggest IOCs in Qatar with huge investments. So we expect them to take a more proactive role.

SE:
From IOC perspective, would you like something more defined than the blank page, so to speak?

Audience Q&A - Rob Sherwin, Deputy Chairman, Qatar Shell:
I think the great thing is that we have the channels of communication open with yourselves, with QP, with all our partners here to have that conversation and indeed identify what are the best spaces. They have to be clearly relevant to Qatar, no point in doing research relevant to California. It has to be things that are relevant and implementable here in Qatar. Ideally, also, of course, one day commercializing here in Qatar; that would be clearly an objective. But also I think it has to be relevant to the work that we're doing here. Otherwise, we might get excited about it one day but we might know that a few years down the line we will lose interest. It has to be things that are genuinely relevant.

We had already re-categorized the work that we were doing under two themes of energy and environment. So I think there's already a very comfortable alignment there. Of course, we do have a variety of other programs; it's not just one. But we look forward to constantly keeping that dialogue going to make sure that there is a really relevant dynamic and well supported.

Faisal Al-Suwaidi:
I should not leave anybody with the impression that there is no progress on this. There is the Texas A&M partnership with RasGas, Qatar Petrochemical Company (Qapco) and others, and the university also partnered with some investors in the carbon capture projects is a partnership Qatar Petroleum (QP) and QCP

Audience Q&A - Dr. Andrew Wigton, Research Director, ExxonMobil Research Qatar:
I'm specifically interested in QEERI because of the environmental component, which is very much in line with what we're doing at ExxonMobil here in Qatar in terms of our environmental management research program. What is your view on the common ground between an industrial research program and the QEERI? Where do you see that common ground?

Faisal Al-Suwaidi:
Let me start by saying that one of my themes from last year's forum was how little people knew of each other. Now, I knew all the people involved in energy in Australia; I knew all the people involved in energy in Europe and the United States. People knew each other, if not by name, at least we saw a picture, we knew what people were involved with.

So here is Qatar, with its size of population and area, and you would think that people knew each other by first name. One of the things that we will be hopefully doing is a new forum to provide the opportunity for people to meet and exchange ideas and network. So this is what my job is. Second is that we are working with the Qatar Statistics Office to develop a science research conservatory. Hopefully when this is done, people will know who's doing what and who's involved with what institution, and provide more data for other researchers within the country. This is maybe a few months down the road.

Audience Q&A - Soren Frank, Maersk Oil Research & Technology Center:
I think you touched on a lot of the things also in my mind. In our Research & Technology Center here we are focusing on improving our recovery and doing that in different ways, and we have an environmental theme. I think as I see it, and you alluded to it pointing to 60% of the economy being dominated by hydrocarbons, we have a great opportunity to develop some kind of center of excellence within these areas. We're already moving into that direction with QP, but it could also be with other institutions here.

One of the questions asked was on the role of QEERI. We're already doing work on enhanced oil recovery with Texas A&M, but would there be a case including them in something like the oil recovery initiative?

Faisal Al-Suwaidi:
As far as the development of strategy last year, we went back and redefined the roles of our entities; one of which is QEERI. The concept there is in a limited number of research areas and this stems from a pool of 72 objectives that I identified in the forum and I'm sure there is room for cooperation.

Audience Q&A: John Roper, MENA CEO, E.ON Energy Trading
Hubs, through their very nature, are not isolated centers. There must be some very obvious common themes throughout the GCC that your ideas of research would replicate. Do you see the Qatar model just revolving around Qatar? Or do you have intention to reach out to other similar research centers, rather than hubs, I guess, in the region? Because there must be a lot of work that there would be no point in replicating that you could actually build on rather than just stand-alone and isolated in Doha?

Faisal Al-Suwaidi:
Like I said, Qatar is very small in population, as well in geography, and when I say in the first instance we're addressing Qatar's needs, then really we are addressing the whole area's needs. If you go wherever in the area and ask what are your most pressing medical issues they will tell you obesity, diabetes, cardiovascular, the same thing. Again, if I look at the 60% oil and gas contribution to the economy here, I am sure it will be 60% in the same places. So we're really talking about one agenda. And, you know, except for one or two countries in the region, we all suffer from the same issues; everybody has human capital issues. So partnership will be an important issue. We have two offices: one is a partnership office, and one is the outreach office.

We need to build bridges between the local investment and our research institute, and the partnership office has the responsibility to build bridges between our institute or between Qatar and the international community. Actually, we had a visitor from Masdar Institute in Abu Dhabi last week and we will see more. We have people from the GCC council coming soon. So I think as we define our research agenda more and more we will be able to go out and strike those partnerships. Internationally, we also have a partnership with MIT, with Imperial in the UK and others. ■

Human Ingenuity, Innovation and Technology Hold the Key to Meeting World Future Energy Requirements

By Youssif Saleh, General Manager,
Qatar Shell Research & Technology Centre

SINCE THE EARLY days of hydrocarbons production, technological innovation has been the decisive factor in increasing recoverable oil and gas reserves. Today, more than ever before, this is still the case.

With global energy demand forecast to double by 2050 and the world's population expected to reach 9 billion, the need to expand – and sustain existing – hydrocarbon production is self evident. Much of these additional hydrocarbons will have to be extracted from reserves in remote and geographically challenging areas, while recovery levels at existing fields will have to be pushed up.

The increased complexity in tapping these hydrocarbon resources means that the successful development and deployment of innovative technologies in the upstream oil and gas industry will be vital, also in the Middle East. To succeed, oil majors, independents, service companies, start-ups, universities and research organizations will all have to play a role. This is as much the case in Qatar as it seeks to establish itself a world-class research and development (R&D) center, as it is in other parts of the world.

Since the turn of the century, technology advances in the oil and gas industry have been rapid. Innovations in the information technology sphere have found their way into the energy sector and altered the way oil companies operate – from identifying reserves to exploring and developing them to production. But commercialization of oil and gas technologies remains a lengthy – and costly – undertaking. It is not unusual for the process to taking a technology from initial research through to making it available to the market to take 15 years or more in the industry.

Still, for large oil companies, investing in R&D and pursuing technological advances such as the ones that eventually led to the breakthrough in shale oil and gas are integral to their business strategy as it is part of ensuring long-term reserves replacement.

A strong focus on R&D is equally important for governments. Being the owners of their countries' reserves, hydrocarbons production benefits governments because it generates multiple income streams and supports certain segments of domestic industries along the oil and gas value chain, thus creating benefits to the local economy. Sustaining and expanding on these benefits by supporting relevant R&D as part of a national energy policy that at the same time ensures the environmentally-responsible and economically-efficient development of its resources to maximize long-term benefits, is therefore in the interest of any government.

As part of its National Vision 2030 and its Qatar National Research Strategy (QNRS), the Qatari government has made a clear commitment to R&D, including in the area of energy and environment. This matches with the R&D themes defined by Shell, which has been a committed anchor tenant of Qatar Shell Research & Technology Centre at Qatar Science and Technology Park since 2005.

Naturally, the R&D being conducted in Qatar has to be of relevance and should be implementable locally. This is certainly an objective at Shell, which has and continues to reach out to the wider education community on the ground, forming collaborations with local industry and academia, and developing young Qataris where possible. But while it is important that R&D projects in Qatar take a specific interest in delivering solutions to local needs, it is important to realize that the technology developed and deployed in Qatar can be globally relevant and commercially attractive in the rest of the world as well.

"Innovations in the information technology sphere have found their way into the energy sector and altered the way oil companies operate – from identifying reserves to exploring and developing them to production.

To fully realize the potential of Qatar's vision, it will be essential for all stakeholders to interact and identify the common ground between international oil companies' R&D activities, Qatar's national vision and research strategy, as well as the various research projects being carried out at universities and research institutes. IOCs are well positioned to – and should - step up to this challenge. But it will require cross-industry collaboration to ensure that the 21st century energy story in Qatar – and indeed globally – will produce the technological advances needed to ensure that the industry's increasingly complex challenges are being met. ■

Youssif Saleh, General Manager, Qatar Shell Research & Technology Centre

Qatar's R&D Ambitions: Challenge and Opportunity

By Soren Frank, Director of Maersk Oil Research & Technology Centre, Qatar

FEW COUNTRIES HAVE pursued their ambitions as rigorously and successfully as Qatar in the past two decades. The Gulf state has become one of the world's leading hydrocarbons producers and tops the list of global LNG exporters. Having established itself as a global energy hub, the country is now gearing up to take the next step by building up the country's research and development (R&D) capabilities as it seeks to transition from a hydrocarbons-based economy into a knowledge-based one as part of its National Vision 2030.

Building on its foundations in the energy sector is a logical extension of Qatar's existing capabilities. Leading international oil companies are ubiquitous and have contributed know how and technology to the country. In recent years, the government's focus on education has attracted some of the world's leading universities to set up shop in Doha, while local universities have been upgraded. Projects such as the Qatar Science & Technology Park and the unveiling of the Qatar National Research Strategy (QNRS) in October 2012 are testament to the government's commitment to its vision.

To be sure, Qatar had been committed to R&D for some time, having allocated 2.8% of its gross domestic product (GDP) annually since 2006 to promote research, technology and innovation. But where there had been a more fragmented approach to R&D in the past, there are now five key pillars consolidated under the umbrella of the QNRS with a focus on: enterprise; energy and environment; computer sciences and information technology; health; and social sciences, arts and humanities.

The consolidation is aimed at aligning and linking all projects and research visions in Qatar. As such, implementation of the strategy will require close collaboration of three key stakeholders: academia, industry and government.

For the oil industry this means building on its existing R&D engagements in the country to address challenges of relevance both locally as well as internationally, and in line with the QNRS. This could be anything from the advancement of enhanced oil recovery (EOR) techniques to making seawater desalination more efficient to helping lower Qatar's carbon footprint. Maersk is already working closely with universities in Qatar such as Texas A&M as part of this challenge. Other oil companies are involved in similar programs.

However, establishing Qatar as a global hub for energy R&D will require deeper collaboration. Traditionally, the goals and objectives between academic research and industry R&D are quite distinct: while academic research aims to enhance global knowledge by publishing its findings, industry R&D is not concerned with publication but set to be applied in 'real life', i.e. commercialized. Bridging this gap will be essential.

From an industry perspective, it is important that universities focus on applying their research. A key element in achieving Qatar's transition to a knowledge-based economy—and a key performance indicator (KPI) for an energy R&D hub—will be creating value from investments into university research that's being conducted, i.e. ensuring that it is being brought to the market commercially.

Getting IOCs to collaborate in joint R&D projects with universities may not always be feasible. IOCs are looking for technologies that are going to differentiate them from their peers and therefore may be reluctant to enter research projects that also include competitors. This does not mean collaboration is out of the question: cooperation can happen where the oil industry has a common interest in developing knowledge, for example in environmental or water issues.

In other cases, IOCs may consider specific areas to be differentiators and thus rule out collaboration. With this in mind, creating a platform that helps identify the areas where collaboration for joint industry projects is feasible will be an important element going forward.

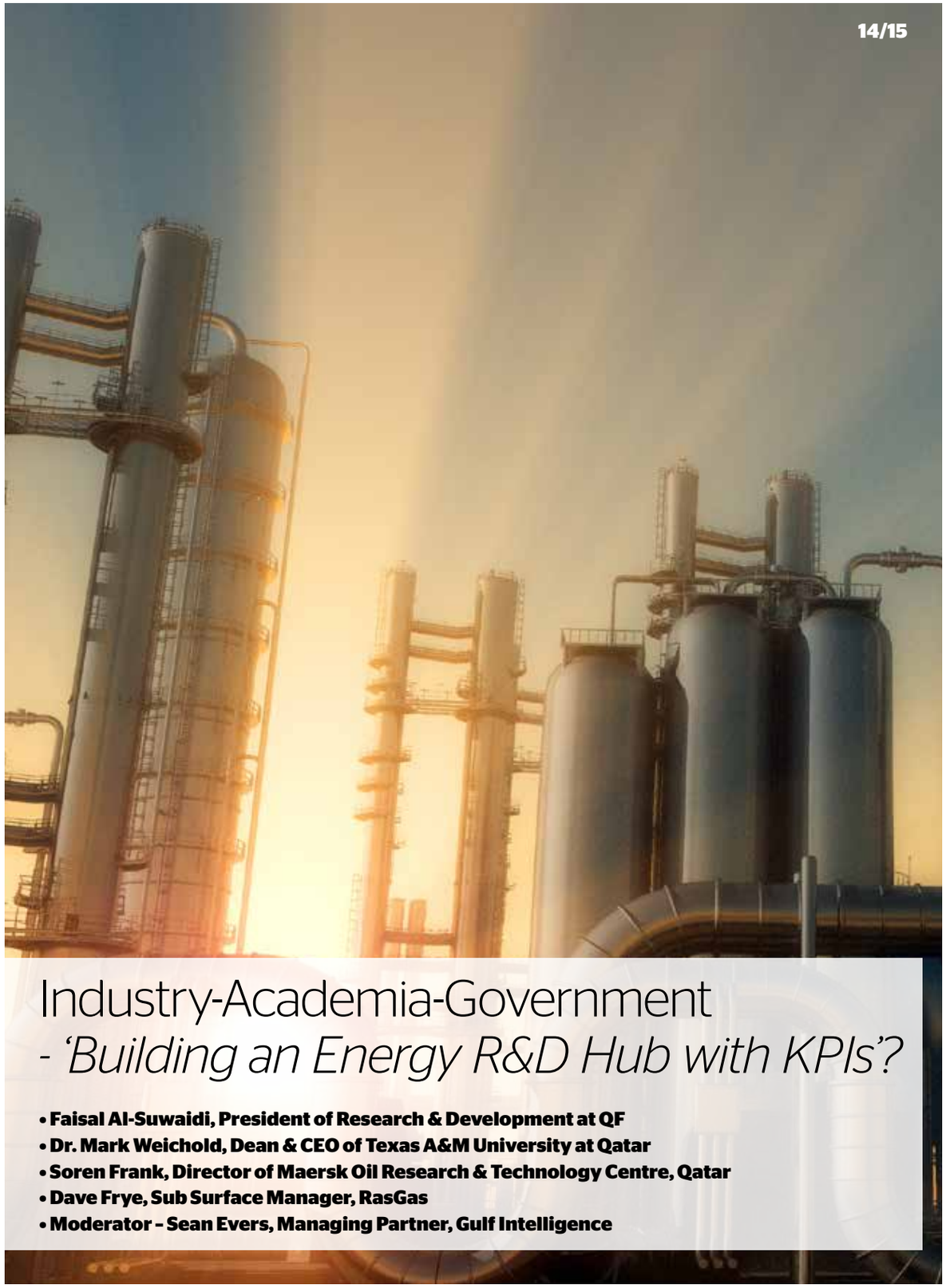
Another key ingredient needed to create a knowledge-based economy—and one that's keenly anticipated by the industry—is the introduction of PhD programs at Qatari universities. For it is at the advanced study level that knowledge is being created, in turn providing the foundations for Qatar's planned transformation away from a hydrocarbon economy.

It won't be an easy task but, importantly, the key foundations for building an energy R&D hub are in place: the government is committed to foster knowledge creation for its citizens; IOCs are engaged in and committed to contributing to Qatar's transformation; a network of local and international universities as well as research centers already exists and continues to evolve.

With that in mind, academia, industry and government agencies now have to take concrete steps to build on these foundations and take the necessary steps to build an energy R&D hub of international recognition. This is as much a challenge as it is an opportunity to create technology breakthroughs in the energy industry out of Qatar. ■

"A key element in achieving Qatar's transition to a knowledge-based economy—and a key performance indicator (KPI) for an energy R&D hub—will be creating value from investments into university research that's being conducted.

Soren Frank, Director of Maersk Oil Research & Technology Centre, Maersk Oil



Industry-Academia-Government
- 'Building an Energy R&D Hub with KPIs'?

- **Faisal Al-Suwaidi, President of Research & Development at QF**
- **Dr. Mark Weichold, Dean & CEO of Texas A&M University at Qatar**
- **Soren Frank, Director of Maersk Oil Research & Technology Centre, Qatar**
- **Dave Frye, Sub Surface Manager, RasGas**
- **Moderator – Sean Evers, Managing Partner, Gulf Intelligence**

Sean Evers (SE):
David, from the perspective of an NOC, as manager of sub-surface for RasGas -- what are your thoughts on the benefits and challenges of building an Energy R&D Hub in Qatar with clear and defined KPIs?

Dave Frye:
RasGas signed an MoU with Texas A&M University in 2006 and we've been collaborating on a number of research projects—all in the area of sub surface—ranging from drilling and completions to well monitoring to reservoir engineering and 3D visualization. What we've found is that this collaboration has really provided a win-win-win-win. It's a win for RasGas in that we find solutions to some of our challenges. I think it's a win for the university because on some of these projects we actually expanded its laboratory facilities and capabilities. Thirdly, it's a win for students, by providing them with very real challenges and projects to work on that will better prepare them for postgraduate. Finally, I think through those first three wins it's also a win for the State of Qatar. As for collaboration, we have to think also about how it fits into the competitive world that we live in. IOCs are looking for proprietary technologies that are going to differentiate them from others. That puts some challenges in place with regard to collaboration.

SE:
In terms of putting in collaboration, projects, partnerships with others, other than the universities, would Maersk Oil Qatar engage with another IOC?

Soren Frank:
The capacities and capabilities we are looking for are differentiators. So I don't see the full point in joining forces with another IOC. What we do have is models for collaborations with universities. If willingness can be worked out also between IOCs then it would probably have to be steered from the national oil companies. There is competition and competition helps making new developments. It's healthy. So I see it as being two pools of projects. We have collaborations where we build up our common knowledge; and the ones where you try to focus on your differentiators. You would have to find out whether IOCs consider one area being a differentiator or not.

SE:
Faisal, are you going to fund five of the same research projects? Are you looking for these partners to collaborate on these needs that Qatar has?

Faisal Al-Suwaidi:
All research proposals will have to compete for funds, so the ones that make more sense will get priority in the funding. There's huge competition between the majors but we will see a situation where we manage to get them to sit down and iron out issues, and discuss and join forces.

SE:
Is that a role for the university, maybe?

Dr. Mark Weichold:
A model that I've seen work, and we have an example of it here in the form of the Qatar Sustainable Water and Energy Initiative that we put in place several years ago, is to develop a consortium-type model or something along those lines. The Qatar Sustainable Water and Energy Initiative is an entity here at Texas A&M where half a dozen companies provide funding and ideas for research. Through a board process these common areas of interest are identified and then funding is provided to a faculty member or in collaboration with the particular partner company to handle liaison and so forth. So I think there is a role. But I think to expect ExxonMobil and Shell to share their deepest darkest secrets is probably not going to happen.

Soren Frank:
You have the super-majors but you also have the smaller independents—I would call us midsize—where you probably have a higher likelihood of having an exchange of ideas and technologies. We are also trying to stay ahead of the game and continue to be innovative. We don't necessarily only work through proprietary technologies—the TriGen technology is an example of a proprietary technology, but that's not the main driver. There are others like our concepts, for example for developing the Halfdan field. The concepts are not patented; people can go out and copy them. We have the competencies in house to actually go out and realize them. We are trying to stay ahead through different relationships, to keep continuing developing these concepts. So that is also a model that works with the oil industry.

SE:
We're still in the early days of this vision of being a global energy R&D hub but given that Texas A&M is a big focal point, obviously a lot of the research partnerships are being aligned with it. Do you differentiate? Is there a China Wall between what a professor can do and what another professor can do, if one project is with Exxon and another is with Maersk?

Dr. Mark Weichold:
No, we have a number of our faculty who work together collaboratively on projects. We have a couple of electrical engineering faculties that are working together so there are no a-priori walls of separation.

SE:
Even though they might be working on different research projects with different clients, different partners?

Dr. Mark Weichold:
It depends on the specifics. There are going to be those opportunities where two faculty members could partner and write a proposal to, say Maersk, for a particular project. There could also be cases where faculty member A writes one to Maersk and faculty member B writes one to RasGas, and they're similar; those two individuals ought to be talking to each other. I think that's a key component of making research successful here. We have a lot of very talented people at Texas A&M, at Qatar University, at the research institutes and so forth. And we do a lot to bring those individuals together, but I still feel in many cases it hasn't congealed into a community. Texas A&M's annual research forum is an excellent opportunity for that networking. It's geared specifically to put our researchers in contact with individuals from the industry. Our first forum last year was very successful. But I think one thing that was missing was an opportunity for the faculty members and representatives from industry to sit down right then and begin to talk about things. This time we're going to have little breakout rooms so that we can get together.

SE:
Soren, what are the issues for you engaging with academia, commercialization, etc.? What advice do you have to make that better?

Soren Frank:
I think the advice to make it better is: try to focus on getting it applied. It's very nice to produce reports, but if you don't have a focus on applying it in the field then it won't happen. I think we're already seeing a wide variety of very strong universities. It is important to get universities to talk more to each other because if you really want to stay in business and make it attractive we need to keep on being creative and start mixing disciplines more.

Dave Frye:
Just to build on that, we look at who are the competitors and it's the IOCs and the oil companies that have proprietary interests that tend to separate them when it comes to collaboration. But there are other opportunities. I think the concept of a research and development hub lends itself to even broader collaboration that we haven't really talked about yet. We've been focused on the energy industry, but there's a lot that we could do to reach out beyond the energy industry to find technologies that we can apply in our industry. One example of that would be imaging technology from the medical industry. In my role, we rely on different technologies, tools that we can run down in the wellbore to see what's going on down there with regard to wellbore integrity, leaks, corrosion, and those types of things. Having a centralized research hub allows us maybe to reach out to other industries and collaborate where we don't have a competitive environment.

Soren Frank:
I think we shouldn't forget that we can actually also deliver something in the other direction.

SE:
Faisal, in terms of encouraging entrepreneurialship in this space, we've talked about the IOCs, the major players, because they are in the energy industry, but what about startups? What about creating an environment for entrepreneurship around research?

Faisal Al-Suwaidi:
This is a good question. For that purpose, we need to think beyond Qatar because it is not big enough; it doesn't have a big enough market. So if we limit it to Qatar's economy we probably won't be able to spin off many companies. QSTP is open to this.

SE:
Can you facilitate the legal process, the application to get a license, etc.? Can you play a role in streamlining those things?

Faisal Al-Suwaidi:
As part of the QSTP, we have the free zone that will provide things much faster than the government or a government department. But again, we still try to improve on other things like IP (intellectual property). We have a law that's not up to international standard. This is something we have on our priority list to work on with the IP office and the government. We are doing so and we're bringing resources to help us do that. So there are a few things that will need to happen, but practically QSTP is there to help develop ideas.

SE:
Soren, how important do you think that is in terms of the creation of this cluster, the creation of an entrepreneurial culture as part of this wider R&D space?

Soren Frank:
Well, I think it is key because it's through entrepreneurship that you get things to happen. It's something that we try to nurture. As a corporation, it's almost always more difficult to actually foster this

entrepreneurial spirit. You talk about spin-offs and opportunities in the region, but it's also a challenge for a corporation to get entrepreneurship. I think to a large degree we have been successful in that and I think it's key to demonstrate that what you do has an impact; and that will be key also for the research hub. You have to be measured also on how many of your ideas actually go out and create value to society.

SE:
Mark, what's your view on entrepreneurship in terms of Texas A&M? How important is that and do you see a role for you if you can get your students' research into that space?

Dr. Mark Weichold:
The next five years at QSTP are going to be very different. I think we're going to see a much more focused effort on the commercialization of technologies. I welcome that with open arms. It is going to be essential if we're going to move toward a knowledge-based economy. Without some mechanism to take the ideas that are generated in university research environments—either independently, say funded by QNRF, or in partnership with other sponsors—to the market there's no value that's being realized from that investment in research. I think it is essential to have opportunities to commercialize technology, to be entrepreneurial. This is the basis on which to build a knowledge-based economy.

SE:
Where does that intersect with the development of a PhD program?

Dr. Mark Weichold:
That goes hand in glove. The undergraduate students at Texas A&M and at Qatar University and so forth, graduate with a very solid engineering foundation. But if we look at the creation of knowledge, that's not the mission of an undergraduate program. The creation of new knowledge comes at the advanced study, at the PhD level. And it's the creation of new knowledge that is the basis for a knowledge-based economy. We certainly have a business plan that anticipates the graduate program in all four of our disciplines. We have the underpinnings for establishing a PhD program here in place in conjunction with Qatar Foundation. A lot of this is going to depend on market demand for the PhD. But again, I think there is a demand in the marketplace for PhDs if we accept that that is the cornerstone upon which the knowledge-based economy is going to be built. So we're planning and we have had discussions on it, not only with Qatar Foundation but also with the Research and Development division within Qatar Foundation and, of course, with the home campus as well.

Dave Frye:
I would just throw a word of caution in here. We're talking about KPIs and measures of success being commercialization of the research and certainly that's very important. As an industry representative here, when I go to bring a specific research project to A&M or others, I'm looking for answers to my problems or challenges and certainly a key performance indicator is finding those solutions. If we throw all of our research towards applied research, we're forgetting some of the foundation and the fundamentals that are present in basic research, and some of that basic research that is maybe not as important to meeting today's challenges but will be the foundation for those future technologies that will make a difference some day. So let's have both a near-term and a longer-term perspective when it comes to research and development.

SE:
Faisal, one thing we didn't touch on in this subject is where does it intersect with Qatarization?

Faisal Al-Suwaidi:
What I would like to see is that we increase the number of Qataris in different sectors of the economy, not necessarily attaching Qatarization. I think we'll see research and education take a priority in the next few years. So we need to direct some of our people with potential to PhD programs that will meet some of the grand challenges.

SE:
What would you identify as the crucial next step that we need to take in order to get closer to the destination of Qatar being an energy R&D hub?

Dr. Mark Weichold:
The Qatar National Research Strategy that we've talked about is an excellent first step. The next step we are probably going to see about a month from now is when that existing National Research Strategy is reviewed, tweaked, modified. What we're probably going to see is a bit more focus on the objectives and the outcomes. So the crucial next step is to continue to refine and define the critical national needs.

Soren Frank:
Another very important point is that hydrocarbons are still a very, very important element also of the Qatar National Research Strategy. I think with that acknowledgment we can start making the links and maybe start inspiring each other by meeting more.

Dave Frye:
We've talked about collaboration and the competitive environment that we live in. There were some good points about finding common areas of interest that could be explored jointly. One of the things that we talked about is to have different IOCs working on different projects and there may be some overlap in those projects. I think one of the things Faisal's group could help with in terms of finding common ground and common interests is to put the right people together to try and see if there's an opportunity for joint industry projects, for example. There can still be a confidentiality-type agreement between those IOCs working on common themes or projects collaboratively, even though they are competitors. They may not be things around enhanced oil recovery or faster drilling, but maybe more humanitarian or environmental-type issues that we all have a common interest in developing. I think it's worth a try.

Faisal Al-Suwaidi:
I think we need to see more dialogue between academia, between researchers and between industry players. If we are to meet the national needs, we better reach out and talk to them. We need to come together. ■

Qatar's Energy R&D Players' Need to Identify their Unique Value Statement before Seeking Partners

By Dr. Nasser Al-Mohannadi, Research and Technology Manager, QP

I WOULD LIKE to focus on the relationship between the industry and academy, in terms of research and development, as well as on the inter-relationship among the industries themselves.

Let's first establish who are the players? We have a National Oil Company, i.e., QP. We have International Oil Companies (IOCs), research institutes [such as: Qatar Energy & Environmental Research Institute (QEERI), which is established by Qatar Foundation(QF)], educational institutes (like the universities) and the government.

So, how do we improve the partnership relationship between the industry and academy? Based on my experience, I think it is not easy and it is really challenging. So, in order to look at these challenges, let's first look at the mandates of individual parties or players in this research community.

For example, what is the mandate of the National Oil Company? Basically, NOCs are guided by looking at the national security of the country's energy, i.e., they look at the source of energy. They are actually the producers, the operators and the owners of the oil and gas fields as well they look and focus more on the applied research taking into consideration that data confidentiality is really important for NOCs.

> "How can we manage talents? How can we secure the talented people at an early stage and give them the career path and recognition, so they are attracted to go through the research?

When it comes to International Oil Companies (IOCs), you'll see in addition to the one I mentioned above, achieving the growth and a competitive advantage over their peers are really key factors those are mostly achievable through applied research.

With regard to service companies, you will see that the service companies, for example, are focusing on meeting the service-oriented customers' needs. They are product' related and they care about the commercialization of their research products.

In terms of the educational institutes, they look at the education itself, the teaching process, the graduates and publications as well as they might not focus only on the applied research but also more on the fundamental research and publications.

The governments, for example, are the regulators. They are the sources of large numbers of challenges. They have the authority to share with us challenges and issues at the national level.

Then comes the local research institutes [such as: Qatar Scientific Technology Park (QSTP) & Qatar Energy & Environmental Research Institute (QEERI) those are, for example, units of Qatar Foundation (QF)] and their mandates are to focus on delivering/achieving the Qatar National Research Strategy.

Considering these different mandates, we need to look at the real current challenges and what success may look like.

Firstly, we need to agree on what is the market itself? Are we having a single market or is it multiple markets? For example, here you will see that the market in Qatar is very small compared to the rest of the world.

Secondly, we need to look at the research culture itself in Qatar. Do we have the recognition of the research yet? Do we have the appreciation and the encouragement in term of research?

Thirdly, we need to consider talents and skills. Do we have the people and the skills to do our research? I think without them, we cannot do research.

Fourthly, do we have the strategic research programs, which are very important to plan for recruiting the people who are needed to work on research, so it's really a key point.

Fifthly, we need to look at the research itself. Whether it should be a fundamental and/or an applied research those are basically more creative than technology implementation? So, some organizations focus on creativity and some of them want applied research. So how can we have a balance in-between?

Finally, the patents' IP rights those are really important and costly to maintain. When do we or do we not want to patent things? For some organizations, it's really a key factor to have an IP right; and some others don't care depending on the research itself.

Now we need to look at the partnership between industry and academy. What does this partnership really create for us?

It will create for us the necessary R&D, only if it is not treated as a social corporate responsibility type of partnership. It needs to originate graduate programs to generate talents those will create an innovation culture for industry and in return they will create applied research for the academic staff to work on. It will help to provide jobs for newly graduated researchers.

The most important is that without having the skills and people, we will not be able to do research. So, basically from all these points, the most important benefit of strong academy-industry partnership is building capabilities and skills for research.

There is a lot of talks about creating R&D hub and reaching the ideal case where all of us and different organizations are working together and searching for opportunities to cooperate on research. So this ideal dream case, as you know, is seen in a distance, but it is not happening now!

So, the million-dollar question is: Do we strive to take one big giant step and create a "push mechanism" to try reaching this ideal position?

Or should we individually seek to take our own smaller realistic steps forward and create the pull to secure recognized achievements those will trigger a "pull mechanism" i.e., where different actors will simultaneously be attracted to work in a harmony and to collaborate on research after understanding respective mandates and recognizing individuals' strengths.

So, I believe in these smaller steps, i.e., the "pull mechanism", because these smaller steps are basically more tangible steps and can bring clarity in several classified areas. Many entities (taking independent and successful forward steps) will reveal on time.

The right structure should be established on how all these parties should work together as a network, as an interactive type of network and as an organized group.

It will bring clarity to the right process itself. How do we collaborate? What does the flow of knowledge and transparency among all these partners look like?

In order to do that, we need a platform to do this knowledge transfer among these parties.

Last, but not least, taking small tangible steps will bring clarity on how to develop the talents & the people. And again, without the people we can't do research. So basically, how can we manage talents? How can we secure the talented people at an early stage and give them the career path and recognition, so they are attracted to go through the research?

Based on my one year experience in leading the QP Research Centre & in order to create the "pull research mechanism" at QP, I think we need to answer the following questions:

How can we show the value of our skills and resources in these small tangible steps? So, that we can attract a partnership business!

How do we deal with the confidentiality of the data from the start of the project until the end, when the results are delivered? ■

Dr. Nasser Al-Mohannadi, Research and Technology Manager, Qatar Petroleum

Building an R&D Hub: Deepening University-Industry Collaboration Will be Key

By Sean Evers, Managing Partner, Gulf Intelligence

WHEN BRITISH CHEMIST and physicist Michael Faraday first began experimenting with liquefying gases, including natural gas, in the early 19th century no one could have predicted what boom the technology developed on the back of his experiments would trigger more than 100 years later. In 1941, the first commercial natural gas liquefaction plant came on stream in the U.S., raising the possibility of transporting the natural resource over long distances.

But it wasn't until 1959 that liquefied natural gas (LNG) was transported for the first time from the U.S. to the U.K. on a dedicated tanker and until 1964 that the U.K. became the first importer of LNG on a commercial scale, taking supplies from Algeria. Ongoing technological advances enabling the construction of ever larger LNG production facilities and tankers coupled with rising global energy demand have since led to a steady increase in the number of LNG producing – and importing – countries. Global LNG trade stood at an estimated 299 billion cubic meters, accounting for about 9% of global gas demand, in 2010, according to the International Energy Agency.

Qatar, which only began to mull plans to develop its North Field – the largest non-associated natural gas field in the world – in the 1990s in a bid to maximize the value of its resources, has risen rapidly to become the world's top LNG exporter. The application of innovative new technologies at an unprecedented scale in the Gulf state, including in partnership with ExxonMobil, has played a key role in making this achievement possible.

Qatar's experience in and emergence as an energy hub and leader in LNG production puts the country and its partners in the energy sector in a prime spot to establishing it also as a center for technological innovation, whether in LNG, carbon management, solar or other areas. The country's National Research Strategy, which was introduced last October, clearly sets out the government's goal to establish Qatar "as an international center for R&D excellence and innovation", with the energy sector as one of the strategy's five main pillars.

"Qatar Foundation has done a great job of laying out the National Research Strategy," says Dr. Andrew Wigton, Director, ExxonMobil Research Qatar. "It's very clear, there are goals, there are priorities, and then there's a word that says collaboration. That brings with it the need for a collaboration strategy as well as a topical strategy."

The benefits of implementing the national research strategy go beyond technological breakthroughs. Establishing Qatar as an R&D hub is integral to the government's vision to foster human, social and economic development in a bid to evolve into a knowledge economy. The latest developments in Qatar have been an important step into that direction.

Funding for R&D projects, supported by the Qatar National Research Fund, is widely available. The Qatar Science and Technology Park (QSTP), located at Education City, was set up in 2009 with the goal to conduct applied research, bring commercialized technologies to the market and support entrepreneurship among technology businesses.

Since its inauguration, QSTP has seen a range of leading reputable universities open campuses and a growing number of international companies establish a presence on the ground to support Qatar's ambitions on the R&D front. From an industry perspective, such initiatives help develop resources internally, using global knowledge, and thus creating a link between the local and international research communities.

Another important element in the drive towards a local R&D hub will be developing and deepening collaboration between universities and industry. Partnerships between oil firms and local academia have been in existence for some time in Qatar's energy sector. Several international oil companies have ongoing programs with the likes of Texas A&M at Qatar and Qatar University.

University-industry partnerships are widely regarded as potential win-wins for both sides. Generally speaking, for industry it may be a way to accelerate time-to-market for new products and services; while for universities it could provide an additional or alternative source of funding.

In Qatar today, there is also a role for industry in helping academia understand what the industry's requirements are and provide support in study program development and so forth. On the side of academia, there is a need to add to existing capabilities by launching PhD programs because it is through advanced studies that universities are able to serve industries. Companies should then be in a position to support PhD students with meaningful projects that address fundamental questions of relevance to the industry and to Qatar.

> "Qatar Foundation has done a great job of laying out the National Research Strategy. It's very clear, there are goals, there are priorities, and then there's a word that says collaboration. That brings with it the need for a collaboration strategy as well as a topical strategy."
>
> **DR. ANDREW WIGTON, DIRECTOR, EXXONMOBIL RESEARCH QATAR**

Formulating a framework under which the benefits resulting from joint research are allocated will also be seminal. As Qatar embarks on its national research strategy, addressing issues such as intellectual property rights (IPRs) will be critical.

From a company standpoint, not all research has to be protected under the same proprietary-type rules. From very strict IPRs to not having concerns over publishing of certain work, the spectrum of research is broad so there needs to be differentiation. Still, all stakeholders—academia, government and industry—will have to find common ground on what often turns out to be a major stumbling block in reaching agreement on joint R&D initiatives.

Says Dr. Ken Hall, Associate Dean for Research and Graduate Studies at Texas A&M University at Qatar: "Qatar is in a very enviable position, developing all this and very rapidly. Qatar has a chance to get it right instead of doing what everybody has done in the past, see what worked, and what didn't work."

By Sean Evers, Managing Partner, Gulf Intelligence

Industry & Academia Partnerships – *'R&D Hub Should Facilitate the Search for Great Ideas?'*

- **Dr. Nasser Al-Mohannadi, Research and Technology Manager, Qatar Petroleum**
- **Dr. Andrew Wigton, Director, ExxonMobil Research Qatar**
- **Dr. Ken Hall, TAMUQ Assoc Dean for Research and Graduate Studies**
- **Dr. Wyatt Hume, Director, Education, Training and Development, Research, QF**
- **Moderator – Sean Evers, Managing Partner, Gulf Intelligence**

Sean Evers (SE):
Professor Hall, what do you see as the predominantly existing hurdles that need to be overcome to make the Academia-Industry relationship a more productive one?

Dr. Ken Hall:
The hurdles I see are intellectual property (IP). In the U.S., Stanford has an excellent model. They develop something, take it, go to Exxon and say, "Exxon, would you like to have this IP?" and Exxon says, "Yes." And Stanford says, "Well, if you make a lot of money on it, please think about giving us some back." Stanford makes more money than any other university off their IP. They do it by just giving it away. The other big issue is publication and there are two other things. One is when industry comes and funds a project at the university they say, "We obviously own the IP because we paid for the project." The facts are that industry never pays for the project. They pay at most about a third of the cost of the project that they come to us with. Federal government is the same way. They pay about a third to a quarter of the cost of the project.

SE:
Currently, the model that's at play is "I will sell you what I have", and you're saying go more open source. Is that specific from your point, in terms of academia needs to be more available to industry or is it the other way round?

Dr. Ken Hall:
Both are separate. I don't think we quite understand the problems each of us have. Industry has the very nice driving force of you must make a profit. We have the driving force of we must publish. Sometimes those two are just not compatible.

Dr. Wyatt Hume:
I don't see impediments. None of us would be here unless a lot of really good things had happened. I agree absolutely with Ken about the issue of IP. It's something that we need to think about very carefully. It's counterintuitive not to want to hold on to ownership, but it pays off. I had the responsibility of looking after the University of California's intellectual property policy for a while and we had our lunch being eaten by Stanford because they were so generous in giving it away. They were making a lot more money than we were.

SE:
That's kind of contradictory in a sense that the better model is not to be obsessed with IP.

Dr. Wyatt Hume:
Somebody should own it and there's always a deal, but get it out there. I do see a lot of really positive things that are happening here; Qatar National Research Fund has transformed this country already. It has changed Qatar University. It's changing already the shape and nature of the branch campuses here. That's a wonderful investment and it was a brilliant thing to do. I think that the Science and Technology Park was a stroke of genius. I wouldn't have planned to do that much so soon, but it's terrific to have it and it's already making a great difference. So I think there are terrific elements in place for very positive aspects of the partnership that you describe. This country is really advanced for a young country in those elements.

Dr. Andrew Wigton:
Building on the discussion, there is a spectrum of research that gets done, all the way from things that need to be protected from a company standpoint with very strict IP, proprietary-type rules in place; to the other end of the spectrum, which is work that we do where we really don't have any IP concerns at all. Within that spectrum, there are different approaches to IP and you may be doing some work where your IP strategy is "the only thing I want is to be protected to be able to use this technology myself without having to pay somebody else". The publish perspective is we're happy to publish that kind of work. So I don't think we should try and lump this all into one category. There are other ways of delivering value to the State of Qatar and delivering technology, other than developing research that leads to commercialized or licensing opportunities in Qatar.

SE:
We have two narratives: one is how you would do this in the big world, in terms of the 'Stanfords' and other institutions in mature markets; then there's how to do it here in the Gulf, in Qatar where there is a slightly unique incubated space being built -- Do you differentiate between the two when building a model?

Dr. Andrew Wigton:
They need to be integrated and recognized. Even though this is an insulated area, it is part

of the broader world. Part of the technology delivery that industry brings to the table is through joint ventures and partners. Another avenue of technology delivery is the work that we're doing at ExxonMobil Research Qatar, that Maersk is doing, that Shell is doing, where we're working on research that's home-grown, on specific issues associated with Qatar. Finding the common areas between the different research institutions that you want to put into a collaborative project is important and not try and force everything into the same bucket.

SE:
Dr. Nasser, what is your mandate and that of QP and the QP Research Division?

Dr. Nasser Al-Mohannadi:
The mandate of our Research Technology Department at QP is to support the existing operation of QP. That's the priority. In order to do that we have to be close to our internal stakeholders and create the channel where we can understand what the challenges are and prioritize them; which ones can we do in-house and which ones can we do in collaboration with the university and with partners—with the IOCs or research institutes. We are going to have a technology workshop internally where we're going to update our technology strategy in terms of the challenges and which ones we can do this year and which ones we can do in the long term. This is something we try to do every two years. But clearly our mandate is to support our existing operating asset of QP.

Dr. Ken Hall:
Right now, Qatar is in a very enviable position, developing all this and very rapidly. Qatar has a chance to get it right instead of doing what everybody has done in the past, see what worked, and what didn't work. Why would Qatar decide to go the same way that everybody else has gone that hasn't worked?

SE:
And what would one of the better ways be?

Dr. Ken Hall:
We mentioned the Stanford model. It works because we're not good at developing IP; that's not what a university is for. We do research all the way from very fundamental research to applied research, but the point is that research is what we're good at doing. We come up with new ideas, we develop the potential for people that can go out and work in the industries. But we're not good at developing the IP. Industry is good at developing IP. That's what they're in business for and we should be getting it to them somehow. It used to be illegal for us (in the U.S.) to patent anything until about the mid '80s. Then all of a sudden it was illegal for us not to patent it. And things were working much better before.

SE:
To better the relationship with academia, what would that be? What's a gap at the moment that you think could be closed that would be a tangible next step rather than a big leap?

Dr. Andrew Wigton:
I don't see a big gap. I see the beginning of a process and part of that will just resolve itself with time. We have very strong relationships with Qatar University and with Texas A&M. We do joint research and there have been very few barriers other than maybe some of the personnel development. But just the fact that we're doing the work and collaborating and sharing some of our expertise is helping to deliver that education kind of technology to the state. So I don't see a lot of barriers, I see the beginning of a process with lots of positives.

SE:
What's the next step in that process?

Dr. Andrew Wigton:
I really feel like the Qatar Foundation has done a great job of laying out the National Research Strategy. It's very clear, there are goals, there are priorities, and then there's a word that says collaboration. That brings with it the need for a collaboration strategy as well as a topical strategy in terms of not everybody is going to collaborate on everything. So identifying the right collaborations and facilitating that through things like the research forum and maybe more things like that, I think would be a good step.

SE:
Dr. Hume, it seems to me that the capacity of academia at the moment is somewhat limited to serve industry in the sense that we don't have PhD programs. Can you tell me from your point of view, what do you identify the gaps to be and what needs to be filled?

Dr. Wyatt Hume:
We already have one great program—about 25 young Qataris are outside of the country focusing on research careers in areas of national importance like better extraction, carbon capture and storage, and diabetes, the full spectrum. It's called the Qatar Science Leadership Program and the young people in it are at Imperial, Oxford, Cambridge, Harvard and MIT. But the numbers are tiny. Qatar Foundation is working to put some of its resource towards attracting young people here to train in Masters and PhD programs in the country; to help institutions here develop Masters and PhD programs; to attract more senior scientists here, which we can do in a few select areas focused on the major challenges that we're defining through QNRS; and to bring the world's best post-doctoral scholars here as well, with the most attractive conditions that we can create. And we're wrestling with ourselves inside the Foundation to make those conditions attractive. The Foundation is working at training as well as recruitment level to bring in 2000 extra scientists to add to the very small present numbers in the country, to attract young people. Some will stay, some will go away but they'll say, "Boy, I trained in a great place, which was Qatar." That will help us in the long run.

SE:
And what about that point that there does seem to be a lot of talent already here that might be slipping through the net?

Dr. Wyatt Hume:
It's exactly the same as the Science and Technology Park, you should make it as attractive as possible to stay here and develop. So we make it as attractive as possible for these young people to stay and become contributors to society, to industry, to research, to education. The country has that capability. Money is not the issue. I think we can be a very attractive destination to keep people, but I don't believe that you have to tie people's hands to keep them here. I'm part of a worldwide generation of people who was attracted to the U.S. I went to California as a young person because it was a great place to be, to develop, to learn, to contribute, and to have a career. Qatar can be just the same. It's got more attractiveness now than just about anywhere in the world.

SE:
Dr. Hall, $10-a-barrel oil changed the industry in terms of the creation of the super-majors, and $100 oil now appears to be reconfiguring it in different ways -- we have seen the service companies, for example, emerge over the last 20 years with a lot of very significant exclusive technology -- How has that altered where R&D is done and where academia looks for partnership?

Dr. Ken Hall:
I don't want to think it changes much because what you saw happening, was a result of fundamental research that occurred maybe 10 years earlier. Technology comes from basic research. It doesn't just appear. Without the background research that went on, none of these advances would have been possible and without the fact that it got transferred to industry, would not have made it possible. We need to have the industry to be able to take basic research and turn it into something useful. We need the research institutes to be in between, to take some of the basic stuff and add to it, so that it's being guided towards commercialization. I think it's an excellent model.

SE:
Dr. Wigton, has $100 oil changed this space?

Dr. Andrew Wigton:
I don't know whether it changed it significantly other than maybe the scale and the number of players; which is always good from a scientific standpoint. The more people are involved, the more chances there are for a great technology to be developed. I don't see any big changes though.

SE:
Do you have any challenges, problems technically in your operations that you cannot solve with the talent you have here?

Dr. Andrew Wigton:
What we work on here is of relevance to the State of Qatar, no doubt. We live in a global economy. So everything that's done here is relevant around the world and things that are done around the world are relevant here. One of our goals is to put in place the research organization as a mechanism to help develop resources internally not to outsource. We hire graduates from Qatar University and Texas A&M. Part of our mission is to develop the local resources, but using knowledge from elsewhere in the world. For ExxonMobil, this is the only research affiliate that we have anywhere in the world, other than our four primary companies in the U.S. But we are developing expertise within our organization and we're transferring that expertise; and the expertise that we're developing and transferring was chosen specifically to address issues that are of great interest to the State of Qatar, namely environmental management, safety, subsurface research and water reuse.

Dr. Ken Hall:
What we want to do here, certainly educationally, from the research institutes' and even from the industry's point of view, is to develop people that look at a situation and don't just see problems, but look at a situation and see solutions.

SE:
What does Qatar need to do to differentiate itself in a global market? Lots of other people want to diversify away from their core by building a knowledge economy -- What is going to make Qatar different?

Dr. Nasser Al-Mohannadi:
I would say in order to develop locals in research you need to create a clear career path, not only in the managerial part, but as well in the technical part, where you can reach out to a subject-matter expert that has the same respect as someone who's managing, for example, the largest field in the world. Second, we need to go back into schools to have students to look into studies and research, put that in their mindset. Third is: how can we increase research among the local people in QP? So we try to promote and attract young locals from other operations to come and work with us part time, to work in research that's running and then go back to their operation. This way, you create a research mindset among them.

Dr. Wyatt Hume:
To answer that honestly I've got to step into territory that I don't understand from the point of view of national politics. But one of the reasons the U.S. attracts the best people from around the world is that it has a visa system and then a path to citizenship for highly productive and valuable people. And I don't know how that sells here, but that would make a difference. It's very difficult for a mid career scientist to give up tenure in either a university or a research institute or a company elsewhere and come here for an uncertain future.

SE:
Can you throw lots of money at that and achieve it?

Dr. Wyatt Hume:
For some people that works, but for some people that won't work. Many creative scientists aren't actually driven by money. It's nice to be well paid, but you want to know that you're going to have stability in your research career development and that your children are going to be educated and live somewhere that's going to become home. ■

Academia Needs to Raise Salaries to Attract the Necessary Talent to Build Qatar Knowledge Economy

By Dr. Hassan Al Derham, VP for Research, Qatar University

IT IS A VERY unique time to live in Qatar. We have seen the establishment of the Al Jazeera News network; Qatar Investment Authority has bought Harrods and invested in Sainsbury's among other investments; and Qatar has become the largest producer of LNG within a very short period of time. All of these advancements and successes have been made possible by the wisdom and the leadership we have in this nation.

With it also comes the National Vision 2030, which is to move Qatar into a knowledge-based economy by the year 2030. Realizing such a vision won't be possible without building local research capacity here in Qatar. A knowledge-based economy is something that a lot of people talk about but, unfortunately, it's not always understood what it takes to achieve this: not depending on hydrocarbon resources or other financial resources, but instead depending on the intellectual minds of the local population and the experts who live in Qatar.

Building research capacity is part of the commitment by the leadership towards moving Qatar into a knowledge-based economy. The government has pledged 2.8% of GDP for research, which has led already to initiatives such as the establishment of Qatar Foundation, Education City, the reform of the K-12 education system, and the reform of Qatar University that took place about 8 years ago. All of these initiatives, together with the establishment of QNRF, QSTP, Qatar Enterprise, Qatar Development Bank, are aimed at building the whole ecosystem and infrastructure so that a culture of research will start to grow and flourish. All this is part of the commitment of the leadership to achieve Qatar's vision.

Qatar is a small country and you can look at it as a weakness because of the limited human resources; but on the other hand, being a small can also accelerate the process of doing things. So instead of achieving things over 20-25 years, maybe you can reach it in 10 or 12 years. So small can be good as well sometimes, especially if you have a global vision and can interact with others to build a global network.

> "If you go to a fresh graduate from engineering, business or law for example, you find that salaries are higher than what we can offer in academia. So this is something that policymakers and policy implementers should address.

The establishment of the presidency for research and development within Qatar Foundation and launching Qatar National Research Strategy will provide a road map for all stakeholders to work together to achieve the country's strategy. However, there are some threats that come with this in the form of miscommunication between different levels within the government sector and also within the private sector here. When you speak with the policymakers, the leadership, they understand what would it take and the sacrifice that everyone has to make in order to achieve a knowledge-based economy. But—and I'll be frank here—when you speak with some of the policymakers or some of the policy implementers, they have a different view or don't really understand it. Or they are not willing to make this sacrifice or take some painful decisions in order to achieve this goal.

Since the nationalization of the oil industry more than four decades ago, Qatar has not built up its R&D facilities within QP or the subsidiaries that come with it. If there is a problem, then a director or a manager usually wants to bring a consultant to fix the problem right away on site because he says 'time is money' and I am losing millions of dollars because production has stopped or delayed. But we have to think medium and long-term so that we can build our national capacity here.

Being a small country also means that we cannot afford to duplicate our efforts. Our human resources are very limited. And it is difficult to attract youngsters or potential students towards research and development sometimes because we cannot beat the financial packages or rewards that they can get in the market. If you go to a fresh graduate from engineering, business or law for example, you find that salaries are higher than what we can offer in academia.

So this is something that policymakers and policy implementers should address. When I was at high school, the government used to provide stipend or remunerations for students who enter the scientific track. Unfortunately, we don't see this happen now but it worked at the time.

Nowadays, we see most of our youngsters choosing literature, humanities or business, rather than becoming what a knowledge-based economy requires: engineers, medical

doctors, physicists, chemists and so on. Building research capacity needs to attract these students to the research and development sector.

One of the weaknesses here is that we don't have a research culture. We raise our kids in a way that you have to follow a particular path. We don't give our kids from an early age the choice and we don't foster critical thinking in our kids and youngsters. This continues all the way until our students graduate from university. This is the difference between students in the U.S. who have an independent, critical mind and an entrepreneurial way of thinking, and our education system and how we raise our kids.

It's a holistic approach. Building a research culture is not only about having infrastructure for laboratories or having research programs or having PhD programs—it has to do with the way we think. You don't necessarily have to be in an R&D institution or organization to think independently or to solve a problem in a logical, methodological way.

Fortunately, we have the QNRF, the funding agency that has helped Qatar University in many ways. We have the QSTP: a very nice building and good tenants. However, this isn't enough. For anyone with an idea who would like someone to support him, it is very difficult. The government has built organization for SMEs, but people approaching them face many barriers. This is another problem that the government at a national level needs to look at, to bring the right people to carry out their duties.

One last thing that I would like to touch on is Q companies as I call them. They have more duties and social responsibility than others. I am talking about Qatar Petroleum, RasGas, Qatargas, Qafco, Qchem – all these companies that have been well established here and are the backbone of Qatar's economy. They have a social responsibility in trying to build this R&D culture. Each company has to have its own R&D facility, section or sector, and it has to be part of the core business and a company's strategy. ■

Dr. Hassan Al-Derham, Vice President for Research, Qatar University

Long-Term Partnerships Key to Building National Capacity for Knowledge Economy

By Dr. Rabi H. Mohtar, Executive Director, Qatar Environment & Energy Research Institute

HYDROCARBONS HAVE been a blessing for Qatar, making it a formidable player on the global oil and gas scene and, as a result, one of the world's richest countries on a per capita basis. The infinite nature of its resources, however, means Qatar – like other hydrocarbon-rich states – will have to diversify away from oil, gas and related industries and transform itself into a knowledge economy.

This isn't new and the Gulf state has pursued a track towards greater economic diversification for some time. Boosted by the discovery of the world's largest non-associated offshore gas field in 1971, the North Field, a vibrant industrial sector has emerged, utilizing cheap energy to fire steel and aluminium facilities, and feedstock such as natural gas to produce petrochemicals and fertilizers. In August 1995, the establishment of Qatar Foundation for Education, Science and Community Development emphasized the need for the country to step up investment to foster education, health and social progress. And in recent years, the government's ambitions to implement the goal of creating a knowledge-based economy have gained further momentum.

In 2008, the government outlined how it would go about achieving its ambitions when it unveiled the Qatar National Vision 2030 to tackle the country's grand challenges in the economic, environmental, human and social sphere. This has been built upon with initiatives such as the Qatar Science and Technology Park (QSTP) that opened its doors in 2009 and the unveiling of the Qatar National Research Strategy (QNRS) in 2012, which is set to establish Qatar as a research & development (R&D) hub of global proportions. The Qatar Environment & Energy Research Institute (QEERI), as a member of Qatar Foundation, is part of this plan. Founded in 2011 and tasked with conducting and coordinating long-term and multi-disciplinary research, QEERI's remit covers national priorities linked to energy and environmental issues. Its trainee program is aimed at preparing Qatari graduates to become leaders in the field of scientific research.

The initiatives are of fundamental importance. Yet, from the perspective of academia and research institutes, there are challenges that need to be addressed. Education capacity building hasn't evolved or progressed at the same pace at which capacity is being developed in R&D. There aren't enough graduates to match this capacity. University curricula need to be developed. Initiatives to attracting more graduates into R&D will have to be drawn up.

This is of particular importance given that it is in the advanced education phase that new knowledge is being created and industry – and ultimately the country as a whole – benefits. At a time of rising populations and skills shortages, especially in the oil and gas industry, developing and attracting local talent to enter the R&D space will help provide the jobs and capabilities needed to enable Qatar to meet its 2030 vision – and develop solutions to real-life problems, whether in energy, water or other sectors.

In light of this, education-capacity building has to take a prime role in the implementation of the national vision and a strategy will need to be drawn up that encompasses the academic and research communities as well as industry. There is a lot of R&D done at industry level that could also be carried out in cooperation between academia and industry. Strategic alliances should be formed to support long-term R&D projects.

First signs are promising: both academia and industry have a clear interest to join forces in R&D and are collaborating in Qatar already, certainly in the oil and gas sector. Thanks to the work done in recent years the foundations to provide and facilitate such collaborations exist, providing a unique opportunity for collective knowledge sharing and access to technical infrastructure. These opportunities need to be tapped in greater depth.

“There is a lot of R&D done at industry level that could also be carried out in cooperation between academia and industry. Strategic alliances should be formed to support long-term R&D projects.

One possible platform to drive this kind of cooperation could be the Doha Carbon and Energy Forum, which first took place in November last year. Originally a partnership between Qatar Foundation and QP, and involving founding member ExxonMobil, it has been decided that the scope for partnership should be expanded. The goal is, eventually, to create a network that cooperates and works on energy and carbon issues.

Collaboration alone won't be sufficient to realize Qatar's vision of becoming a knowledge economy. Building the infrastructure, setting up the research programs and fostering collaboration is one thing. But there is another element. Society as a whole has to embrace a culture that supports independent thinking from an early age, thus paving the way for the younger generations to development the interest to take on the opportunities that R&D has to offer and consider it as a career choice. ■

Dr. Rabi H. Mohtar, Executive Director, Qatar Environment & Energy Research Institute

'How to Move Beyond CSR to Build Long-Term Partnerships that Build National Capacity for a Knowledge Economy'?

- **Dr. Hassan Al Derham, VP for Research, Qatar University**
- **Adel Ahmed Albuainain, General Manager, Dolphin Energy, Qatar**
- **Ryan McPherson, Regional Director, Industry Technology Facilitator (ITF)**
- **Dr. Rabi H. Mohtar, Executive Director, Qatar Environment & Energy Research Institute**
- **Moderator - Dyala Sabbagh, Partner, Gulf Intelligence**

Dyala Sabbagh (DS):
Dr. Derham. From the policymakers' point of view, do you think the academic environment is not getting the support from policymakers?

Dr. Hassan Al Derham:
Yes, I have felt this during my experience. During the last two years, after the launch of the National Vision 2030, when we went to discuss certain issues with some of the policymakers, I found that either they don't understand what a knowledge-based economy is, unfortunately, or what it would take to become one. Maybe they would understand but weren't willing to move towards it as it takes some painful decisions.

DS:
Why do you think this is? Is it a lack of understanding?

Dr. Hassan Al Derham:
People tend to choose the easy track. But if you really want to move on, you need to try to achieve a level of quality, of perfection, in the future. The General Secretariat for Planning and Development, they are carrying the National Vision together with the Qatar National Development Strategy. But when you go to different stakeholders, you find that some of them are doing their duties unwillingly or some of them think "why should we do such a thing"? For example, if we do our part as a national university, setting certain rules for our students, then you will get many complaints, not only from the students but also from their parents and even policymakers.

DS:
Due to funding issues?

Dr. Hassan Al Derham:
No. What I'm talking about is that in order to provide society with good graduates who will pursue their economic and social development to reach such vision, you need those graduates to have the minimum skills in terms of communication, critical thinking. When you take such measures within the university, you develop your curricula and your programs towards this goal so you can prepare society to move towards the 2030 knowledge-based economy vision. But people try to pull you back from doing such a thing.

DS:
Dr. Rabi, what's your opinion on that? Do you see that resistance from policymakers in terms of encouraging this independent thinking?

Dr. Rabi H. Mohtar:
I certainly see a gap between the R&D education capacity-building community and the grand challenges that the Qatar National Vision 2030 has identified. If I look back at the R&D sector, at the education institution, I think there is a gap and we need to mobilize all of our efforts towards filling that gap. I'll give you simple examples: Alternative energy, renewable energy and solar energy are areas that are implicitly identified by the Qatar National Vision. We're building that capacity but we don't have the curriculum. So I would echo what Dr. Hassan mentioned: we don't have the graduates that will fill that gap. It is the same with water sciences. Water and energy cannot be separated. The oil industry is one of the major water producers, yet those links have not been identified as priority areas for us.

DS:
Why not? You have the academic industry who is clearly trying to communicate to the policymakers that there's a gap; funding is not an issue. Why is there resistance?

Dr. Rabi H. Mohtar:
I don't know where current resistance is but I think there has to be an implementation strategy for the Qatar National Vision where the academic community, the research community, is part of that process. I do agree with Dr. Hassan that the academic community was not involved in development of those plans—and they need to be part of that implementation strategy. So we have ambitious goals and to get there, there has to be national capacity building and there has to be significant participation from the academic community, from Qatar University, from Education City, from branch campuses, from the research institute and from industry to mobilize national resources toward meeting the goals of the Qatar National Vision. I think there's a gap, certainly in the implementation.

DS:
How important is the push that needs to come from industry hand in hand with academia to the policymakers?

Dr. Rabi H. Mohtar:
It is very promising because there certainly seems to be interest from both sides to work together. I'd like to see this on the ground with specific projects; but not only short-term projects, strategic alliances. Certainly industry

does play a role. There's a lot of R&D done at industry level and some of this could be in the form of cooperation between academy and industry. So industry can play a significant role in filling that gap and I think they should have a seat on that table.

DS:
Mr. Albuainain, what do you have to say about that from an industry perspective?

Adel Ahmed Albuainain:
Just to continue talking about the link between academy and industry. We see a strong relationship and I think we really need each other. At the end of the day, we see this is a win-win. I need the university graduate. We have a working program with Qatar University, with Texas A&M, because these universities are graduating at engineer level and with the quality we need for the industry. The majority of our business is in engineering. We need engineers.

DS:
What needs to be done to educate students at an earlier stage as to what opportunities exist in the scientific field? What incentives need to be given to them?

Adel Ahmed Albuainain:
I think that the conversation should start early. If I had the chance to meet students before they go to university—and I do that from time to time, meeting students just before they finish high school and have them come and visit—then we direct them towards areas that industry needs. So they won't waste time and spend four or five years studying and then search for a job just to have a job and salary. I think this doesn't support the community. One of the main pillars of the Qatar Vision 2030 is people. But there is a certain gap between the industry's need and the type of graduate from university.

DS:
What about the challenge of the limited resource pool that we're talking about? I mean, however much you try and encourage the local population or the local students who might go into this field is there still a need to build an attraction for people to come from outside as well to enter academia?

Dr. Rabi H. Mohtar:
I'd like to make a slight distinction because we're talking about two very, very important issues but they're somehow distinct. One is

the education side and the capacity building, whether it's undergraduate education and creating awareness about the opportunities that exists in industry or graduate education. That's one side, education-capacity building. But parallel to it is what academia can offer to industry in terms of know-how, knowledge. These two are distinct because they offer two different things and I think somehow we're mixing them together in the discussion. But in the graduate education phase, they merge; because graduate education provides that new knowledge that provides new solutions. I certainly believe that these solutions have to address what the country needs and the industry needs for a country like Qatar.

DS:
What's your perspective on getting companies to work together on research projects that seek solutions to common challenges?

Ryan McPherson:
I think it has evolved over the last couple of years and I do echo some of the comments. I think that the framework here within Doha is second to none at the moment and that's actually been noticed by a few of our members. ITF is owned by 30 different international oil and gas companies, a number of which are located here within Qatar. During the time that we've had the office here, just over two years, our eyes have been opened and also that of our members. Whilst perhaps the culture is still evolving and it is slow steps, it's a little bit more advanced than people originally thought. A case in point is we currently have a project that may go off here in Qatar with one of the universities where we've been able to secure the interests of nine international oil companies, three of which have no presence within Qatar whatsoever, no ties. One is from Europe and purely because they see the merits. It's a local need, it's in the realms of produced water, it's very much focused around a local solution that has international application and the companies are looking at this, saying, "This is what we are now considering to be a center of excellence or certainly somebody is offering something that we don't currently have in our portfolio."

DS:
And these companies, they've come together in conjunction with the academic institutions here, you've brought them together?

Ryan McPherson:
The companies in question have come together because their view is that no one is more advanced than the next and there's more to be made by coming together, sharing a degree of knowledge amongst each other and the risk as well. If we're looking at R&D, there is a technology envelope that you're pushing and they view that the risk is borne less by coming together in this instance. It's certainly not the model that you're going to use all the time, but there is a time and a place and Qatar is set up for that better than most with the QSTP. You already have people working alongside each other, the forums that you have today where there's a degree of openness in the level of discussion, the culture is here and I think, having travelled around in similar guises, I'm always impressed when I come out here and see that level of engagement.

DS:
Dr. Derham, you mentioned that you think that the Q companies need to take more responsibility in coordinating their efforts towards establishing a stronger R&D and national capacity for R&D. What is it that they're not doing that they need to be doing more of?

Dr. Hassan Al Derham:
I think this is something that is doable. Take for example a country like Norway, oil took off probably in the late '60s, early '70s and now they have the know-how and technology to explore and produce, and they have a very successful company. We can do something similar here, building a strategy that has R&D at its core. We are blessed here, supported by international companies like ExxonMobil, Shell, ConocoPhillips, Maersk, all these are available and I'm sure they are willing to work together towards drawing up a framework, a strategy towards developing local capacity here together with academia and the research institutes. I think this is essential. Another simple example is: when the Soviet Union sent an astronaut to space, the U.S. responded by saying they will send a man to the moon by the year 1970. It was like a national threat. So they developed a comprehensive plan that started from education level and they achieved it. Why don't we do something similar? The bread and butter of Qatar is LNG. Why don't local companies, or Q companies, work in developing their research programs and capacity to build up their know-how. The same applies to water. Our security is threatened by water scarcity so desalination becomes a very important topic to work on. We have to set a target for all the people here in Qatar and they have to work together so we achieve it.

DS:
Why aren't they more R&D centers? We've got the academic institutions doing their research but are R&D centers focusing on the natural strengths and resources of Qatar? For example, why isn't there a specialized R&D center on water, with desalination being obviously a big topic across the Gulf.

Dr. Rabi H. Mohtar:
That's what we've been doing, focused research. We're looking at low-carbon technologies for producing water. Water production is the enabler to food security, to domestic security on water supply. But it's also one of the most energy-intensive processes we know today. So can we solve the water problem looking into low-energy technologies, specifically solar? I think we might see in the near future a more focused effort. Maybe a combination of industry, academia, universities and research institutes will say there is a grand challenge that lies out there that's not addressed by any of the current infrastructure. We need to create the discussion or the platform for the grand challenge to open the door for creative ideas. One thing I'd like to clarify is the issue of duplication. Personally, as a scientist I'm not concerned about duplication. If my next-door neighbor is working on the same project as I, then I look at this as two trials to find out a solution to a problem. I don't look at it necessarily in a negative way. But I would be concerned about structural duplication. In terms of the programmatic areas, if you look at the enormous challenge that we face to go from 500, 600 scientists today to 7000, then we need to work together. As a scientist, I need three, four, five different data points on a technology that I develop. So these are eminent solutions. If we work together on the same desalination technologies I look at it as a positive.

DS:
I'd like to ask a question about lining up the Q companies and lining up the core companies to take on a greater capacity, and where those two meet. How can they proceed to build that capacity and is there capability, willingness and desire to do so, and how can those two things be metered?

Adel Ahmed Albuainain:
In Dolphin, we have a continuous program with the universities and we can absorb as many Qataris who graduated from Qatar University and Texas A&M as possible because this fulfills our requirements. We feel by supporting these types of initiatives and programs, we work hand in hand with the universities because at the end of the day, we complement each other. I mean, when we have this program implemented, we will ensure that we get the right candidate for our business.

Dr. Hassan Al Derham:
I also think that, because oil companies face similar challenges, we should have a forum that would bring all this together under one roof with academia to understand the concerns and the challenges, and try to come up with an action plan, a road map for all the companies so they can work together. Maybe it is difficult and maybe it's not affordable for each company to have its own R&D. However, they can probably work together with academia, with the QEERI Institute or with others so that with time they build their capacity.

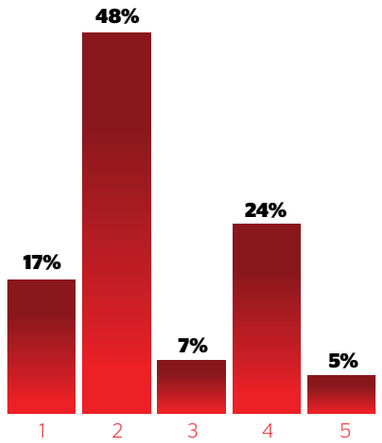
Dr. Rabi H. Mohtar:
For example, the Doha Carbon and Energy Forum, which happened first in November 2012, with a second one to follow in November this year, is a partnership between Qatar Foundation and QP, and the first founding member was ExxonMobil. The founders have decided to widen that scope for partnership. So this could be a platform, because the idea is not only to limit it to a forum but to create a network that works together towards energy and carbon issues. This could be one of those platforms in which some of these discussions happen. ■

Align Academia & Industry R&D Mandates, Survey Says

Technological advances have always been at the heart of the global energy industry, allowing it to open up new frontiers in the quest for undiscovered hydrocarbon resources and boosting efficiencies in their recovery. Driving this kind of innovation and building an energy R&D hub with global reach sits at the core of Qatar's national strategy. The Gulf Intelligence Survey has sought the views of energy executives attending the Doha Energy Forum to give their opinion on what it will take to achieve this goal.

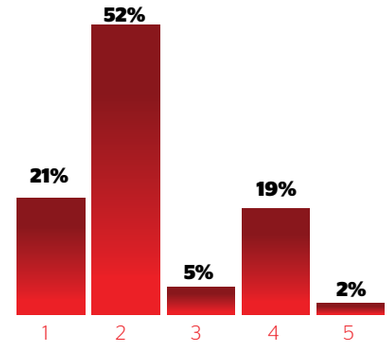
Q1. **What is the most important next step to achieve Qatar's goal of establishing Doha as a global hub for energy R&D?**

1. Reduce Bureaucracy
2. Align Academia & Industry R&D Mandates
3. Impose KPIs on all branches of the Qatar R&D community
4. Facilitate Entrepreneurism in R&D
5. Bolster hard infrastructure for R&D



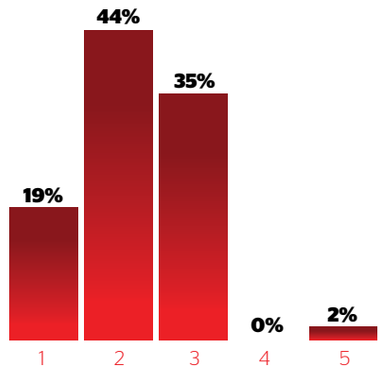
Q2. The development of local national talent in countries rich in energy resources across the world, especially in the Middle East, is one of the key ways for the global energy industry to mitigate the pending talent crisis and build a sustainable capacity to meet future demand. **– Which of the following is the most important commitment for industry to adopt in order to develop the necessary quantity and quality of local talent?**

1. Promote Successful Mentors
2. Industry needs to build clear career path to senior management for technical competence
3. Attract Women into the industry
4. Every company should mirror state and deploy 2.8% of revenue to R&D
5. Move beyond a CSR approach to Qatarization



Q3. Universities and industry, which for long have been operating in separate domains, are rapidly inching closer to each other to create synergies. Higher education institutions not only contribute skilled human resources to business, but also in various intangible ways. The intersecting needs and mutually interdependent relationship requires identifying means of further strengthening academia-industry partnerships **– What is the most important factor to get right to ensure this happens in the Qatar energy vertical?**

1. Align commercial ambitions of academia and industry into win-win
2. Align research expertise done in country with local industry needs
3. Build academic capacity i.e. PHD programmes
4. Industry needs to focus more on R and less on D
5. QF to facilitate partnership not participate in partnership

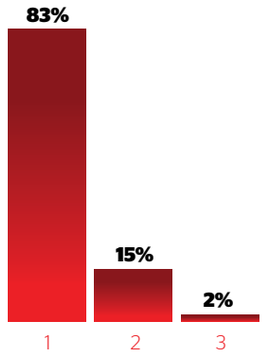


Q4. **Fundamental research provides the basis from which new technology emanates -- Should QNRF emphasize basic research or a mixture of basic and applied research?**

1. Basic Research
2. Mixture of Basic and Applied Research?

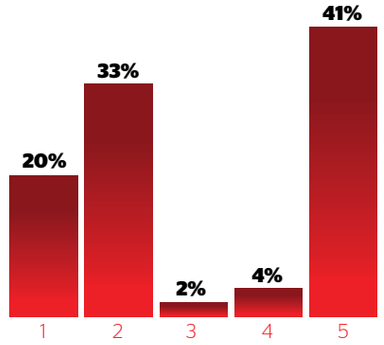
Q5. **Given that Qatar desires to move toward a knowledge-based economy and that PhDs receive training in knowledge creation, when should Qatar build its own PhD programs?**

1. Immediately
2. Within 5 Years
3. Within 10 Years



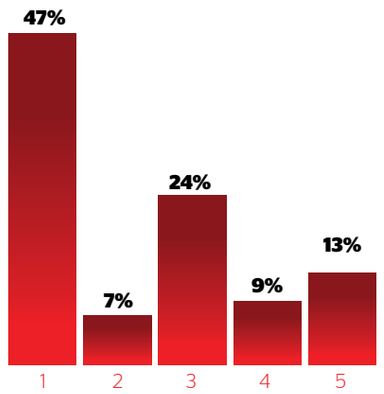
Q6. The Qatar National Research Strategy has been recently launched at the 2012 Joint Qatar Foundation Annual Research Forum and Arab Expatriate Scientists Network Symposium. **What is the most important contribution that the Qatar oil and gas sector is looking to the QNRS to deliver?**

1. Guidance on what are the priority areas to focus R&D resources on
2. A roadmap on how all the different R&D silos should integrate – Qatar research institutes, the QSTP, and the QNRF contributing to the QNRS
3. KPIs
4. Facilitate a research bridge between NOC and IOC
5. Deliver the Human Capital needed to build a R&D cluster



Q7. In the wake of $10 oil in the late 1990s we witnessed significant consolidation in the energy industry with a wave of M&A activity redefining the sector. In the wake of $100 oil we are witnessing a new transformation, less defined perhaps but equally as dramatic– NOCs are becoming IOCs; Super majors are slimming down; Independents are pioneering risk; Service companies are holding taking on IOC activities **– which of the following will be the most significant game changer to watch for its bearing on where the next best technologies will emerge in post-easy oil era?**

1. NOCs are becoming IOCs with access to buy/ commission bespoke R&D
2. Super majors are slimming down and offloading key talent
3. Independents are now the key risk pioneers with USP on post-easy technology e.g. EOR
4. Eroding math capabilities in western academic institutions
5. The premise of the Question is bogus



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