CSIS Saudi-US Energy Forum

The Role of Technology in Meeting Future Energy Challenges

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Remarks by

Abdallah S. Jum'ah

President and CEO, Saudi Aramco

Technology: A Key Enabler of Long-term Petroleum Supplies

Distinguished Guests, Ladies and Gentlemen,

It's a pleasure for me to be in Washington DC for this annual event and see again so many old friends and colleagues. This meeting not only helps us deliberate on issues of importance to America's long-term energy security but reinforces the fraternal ties existing between our two nations. I would like to commend CSIS for continuing to promote this dialogue.

Future Energy Demand and Continued Central Role of Petroleum

Energy in general and petroleum in particular are increasingly in headlines due primarily to market volatility but also because demand is continuing to rise. And despite pronouncements to the contrary, there seems to be a consensus that oil and gas will remain dominant energy

sources for at least many more decades to come, and they will remain central to America's energy future.

Role of Technology in Securing Long-term Oil and Gas Supplies

A key energy challenge facing the industry today is to grow petroleum supplies to meet burgeoning demand. Technology lies at the heart of responding to this challenge.

Many times when people think of petroleum industry, the first images that come to mind are of an industry that continues to rely on decades old technology with workers wearing soiled clothes and toiling on a grubby rig. It is seldom realized how obsolete these images are.

In many applications today, the petroleum industry uses space-age technology. The use of this advanced technology is crucial to the task of finding new oil and gas resources deep under the earth, developing them cost effectively in harsh environments, and doing so in an environmentally-friendly manner.

Oil and Gas Resource Potential as Technology Target

One way to explore the role of technology in expanding petroleum supplies is to consider the resource potential of oil and gas as "technology targets." If we were to focus on this approach, four major and distinct targets quickly come to mind: they are the known oil fields, the yet to be discovered oil fields, non-conventional heavy oil, and of course a variety of gas resources. We can look at this approach as a *four dimensional technology framework*. In fact, I'll adopt this framework for my discussion today focusing on technology's many contributions to help grow supplies and meet global energy challenges.

Dimension I: Enhancing Oil Recovery from Known and yet to be Discovered Oil Fields

I'll begin by looking at conventional oil in *known* fields. The *currently proven* oil reserves in these fields are estimated by various agencies at about 1,200 billion barrels. The reserves *growth potential* of these fields is estimated to be around 700 billion barrels. So, the world seems to have at least 2 trillion barrels or more of recoverable oil in known fields. Our mission is to identify, develop and implement technologies that will turn this resource into supplies, and to enlarge it even further.

The fact is that today only a little more than *one-third* of the oil on average is recovered from known fields, while almost two-thirds are left in the ground. This oil clearly offers a massive opportunity that can benefit from technological enhancements. In fact, such technologies would also help enhance recovery from yet to be discovered fields. The significance of this goal can be judged from the fact that increasing recovery by just 1 percent would add about 90 billion barrels of oil to global reserves.

The good news is that the industry has been working hard to improve technology in all key areas, which are mainly drilling and completion, production, and reservoir engineering, including enhanced oil recovery. **(I'll focus my discussion on onshore technologies as offshore technologies are being addressed by my colleague Rex Tillerson).**

Haradh-III Example: Our most recent crude oil development of the Haradh-III project in the Eastern Province of Saudi Arabia is a classic example of what the industry is doing to better develop and manage fields using state-of-the-art technology. This field has been developed

using multi-lateral maximum reservoir contact wells, which also utilize the "smart" completion technology, and the ground-breaking intelligent or i-field concept. This means most wells are equipped with subsurface and surface sensors that can transmit measurements of pressure, temperature and oil, gas and water production in real time to our data centers. These data become incredibly powerful in the hands of our integrated teams of multi-functional professionals and managers, enabling them to more efficiently manage the fields.

Other Onshore Technologies: A few other advancements include the geo-steering of wells, which means real time control of well trajectories to hit optimum reservoir targets; more advanced reservoir simulation; and three-dimensional visualization of integrated reservoir data to make better decisions. Saudi Aramco is aggressively leveraging these and other technologies, and so are many of our colleagues in the industry.

Reservoir Management: Alongside technology hardware, prudent reservoir management is the key to maximizing economic recovery of hydrocarbons. You may recall that I outlined Saudi Aramco's reservoir management philosophy in a presentation I gave here at CSIS in 2004

Dimension II: Finding New Oil and Gas Fields

Moving to the second dimension of my technology framework, the yet to be discovered oil fields are expected to yield some 1 trillion barrels or more, which provides us with another massive technology target **(Of course, the exploration of gas fields is an equally important objective)**.

Looking at exploration, a wide range of improvements achieved in seismic technology are some of the most exciting advancements made

by the industry. Two-dimensional seismic used to be the mainstay of exploration activities around the world. But now 3-D seismic is routinely utilized, which has dramatically improved the success rate of exploratory wells, besides of course helping in fields' development. In the difficult area of sub-salt exploration, seismic imaging has made great strides, something that was not possible with conventional seismic.

To support a wide range of upstream applications, the industry continues to make massive investments in advanced computing technologies. For example, the computing capacity at our Exploration and Production Engineering Center has reached 23 Teraflop, or trillion floating point operations per second, which is a 200 fold increase over 1999.

These and other advancements have put the industry ahead in the crucial search for new oil and gas.

Saudi Aramco Technology Program Sharply Focused on Our Current and Future Needs

Considering Saudi Aramco's own requirements today and in the future, our technology program is *sharply focused* on the first two dimensions of the technology framework I have outlined. However, many of our industry colleagues are engaged in a broader mix of technologies, driven by their interests in various opportunities across the globe.

I'll now address these technologies and their resource drivers as the remaining two dimensions of the technology framework. I must stress that technology efforts by all of us in the industry, regardless of their emphasis, are complementary in nature assisting the industry in meeting the world's growing energy needs.

Dimension III: Non-Conventional Oil Resources

The *non-conventional* heavy oil resources, which include extra heavy oil, tar sands, bitumen and oil shales, have received less attention in the past. However, considering their enormous *in-place* amount of some 7 trillion barrels, these resources offer a striking target to which technology can be applied. In fact, a key difference between conventional oil and non-conventional resources is that the non-conventional resources are mostly known and technological advancements are the key to turning these resources into supplies.

If we were to contrast the factors behind the supplies of non-conventional oil and conventional oil, we would discover that the challenges faced by conventional oil are relatively minor compared to what it would take to grow non-conventional oil supplies. That's where technology comes in. **(The factors I have in mind include development problems, low recovery rates, environmental issues, availability of sufficient water and gas, processing difficulties, and the overall supply costs)**.

Dimension IV: Natural Gas

The last big technology target that I would like to highlight is gas - in fact gas from multiple sources, some of which are technologically more challenging than others.

Various institutions, including the EIA, estimate the proven reserves of *conventional* gas around the world to exceed 6,000 TCF. In addition, the US Geological Survey believes that there may be another roughly 4,300 TCF of gas resources yet to be discovered. Technology is a key driver

that will help in turning these resources into supplies, and grow them even further.

But that's not all. There are also large resources of *non-conventional* gas. IHS Energy estimates the recoverable gas resources at about 550 TCF each from coal beds and tight lithologies, respectively **(The latter is for the United States alone)**. Then there are gas hydrates with *in-place* quantities reaching a staggering 90,000 TCF **(Of these, about 3,000 TCF of in-place permafrost resources may be developed in the near term)**.

The point I want to stress here is that the transformation of these resources into supplies will require exceptional advances in technology.

People

I would be remiss if I did not emphasize that people are the key to both developing and effectively applying technologies. However, attracting and retaining top technology talent is currently one of the most critical challenges facing the industry. Fortunately, Saudi Aramco has invested heavily in sponsoring hundreds of students who are currently studying earth sciences and engineering in colleges in the Kingdom and around the world. However, like our industry colleagues, we'll need to further strengthen these efforts.

Concluding Remarks

In closing, there are plenty of petroleum resources in the world, and oil and gas will remain the bed rock of global energy supplies for at least

many more decades. These supplies will be increasingly sourced from the Middle East. The challenge is to convert the resources into supplies, and technology unquestionably will play a central role in meeting this challenge **(I should note that a vast share of this technology is being developed right here in the United States).** Saudi Aramco's strong technology emphasis is consistent with our belief that advancements in this area will remain a key enabler of ample and reliable long-term petroleum supplies. Of course, other important enablers are investments and favorable government policies, especially by major consuming nations, such as the United States. The challenge is enormous, but I'm confident that working together we'll meet it.

Thank you.