

# New R&D White Paper Addresses Challenges for Future Energy Supply

Ted Moon, JPT Online Technology Editor

Over the next 30 years, the world's economies will need more energy to fuel their growth, and the oil and gas industry will have to increase investment substantially in research and development (R&D) in order to keep pace. This fact is the central theme of a new white paper from SPE's R&D Advisory Committee titled "The R&D Challenges to Secure Energy Supply for the Third Trillion Barrels and Beyond."

The third trillion refers to a US Geological Survey estimate that there are more than 3 trillion bbl of recoverable conventional oil worldwide, with one-third already consumed and the remaining two-thirds largely in the possession of national oil companies (NOCs). As worldwide energy demand grows by more than 50% by 2030 [according to the International Energy Agency (IEA) *World Energy Outlook 2006*], the oil and gas industry will need to rely heavily on R&D advances, according to Vikram Rao, SPE, Chairman of the R&D Advisory Committee and Senior Vice President and Chief Technology Officer for Halliburton.

"The 12-member R&D Advisory Committee has raised a number of initiatives since its inception in 2002, all designed to raise the profile of R&D in the energy industry," Rao said. "The committee's new white paper was written with one initiative in mind, to promote awareness of R&D challenges impacting the industry to an audience outside of the petroleum community."

"The white paper is mainly concentrated on demographics of what the next 1 to 2 trillion bbl will look like," said Arnis Judzis, SPE, one of the paper's main committee coauthors and Vice President of Schlumberger Data and Consulting Services. "We wanted to relate the myriad challenges associated with producing the unconventional and alternative energy sources that will be needed."

Rao agreed, adding that, "It was intended to be a manifesto, a way to shed light on the imperatives for the industry, and to begin a dialog on the areas of endeavor that are fruitful for R&D."

Before the industry can bear the fruits of an increased energy offering, a significant increase in oil and gas R&D spend-



Rao

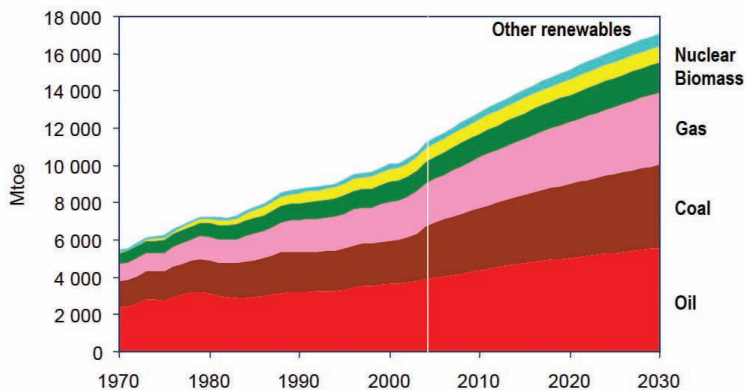
Judzis

ing will be needed. According to 2007 estimates by the IEA, this investment will need to be on the order of USD 8.2 trillion over the next 25 years. Over the past 25 years, energy R&D investment as a percentage of total R&D declined from 10% to roughly 2% in the US alone. The IEA reports similar declines on a global scale over the same time period.

Major R&D investments over the past 15 to 20 years have focused on technologies designed to find and produce more conventional hydrocarbons, including advances in 3D and 4D seismic, directional drilling, and production in frontier areas such as the deepwater Gulf of Mexico and Brazil. "These technologies will not meet our future needs, and we will need to collaborate on new technical innovations and diversify our energy supply going forward," said Rao.

## Collaboration Critical

Collaboration, both across the industry and across the globe, is one of many important themes of the white paper. The committee identified several successful industry collaborations, such as the DeepStar joint-industry technology-development consortium, focused on developing the necessary technology to increase production and reserves in deepwater regions. The paper also identified the important role of professional societies in facilitating technology trans-



**Fig. 1—According to the IEA, global energy demand (expressed as million tonnes of oil equivalent) will grow by more than 50% over the next 25 yrs.**

fers and application. For example, SPE's creation of the R&D Providers Directory on SPE.org and its organization of the first R&D Conference in 2007 in San Antonio, Texas, were highlighted as specific examples of society involvement.

The committee also stressed the need for further collaboration between industry and academia. "I see the role of academia as becoming much more important going forward than it was during the last 20 years," Rao said. "This is because energy sources are becoming more complicated, and the very molecules we are trying to convert are more challenging than what we are used to with conventional crudes. We will need to draw on the scientific rigor of academia to help solve these problems."

This collaboration has to include researchers from other industries and academic disciplines. The white paper highlighted the need for input from chemists, biochemists, and chemical, electrical, and mechanical engineers to extract increasingly complex unconventional energy sources. "In terms of input from other industries, there is no greater example than nanotechnology, in my opinion," said Rao. "Nano could be the vehicle for a great deal of problem solving, from deep upstream to deep downstream. We have been using nano almost by accident in the upstream sector for nearly 80 years in drilling, since the drilling-mud particles we employ are colloidal, nano-sized particles."

### Focus on Unconventionals, Conventionals

Unconventional gas and oil resources received a great deal of attention in the paper as well, because they present production challenges. For future production optimization, new technologies will be needed, as these unconventionalals represent an enormous potential payout. For example, worldwide reserves of coalbed methane are estimated to range from 100 to 260 trillion m<sup>3</sup>. In the US, shale gas has grown in prominence in recent years, and improvements to fracturing fluids and novel perforating techniques have helped make the large Mississippian-aged shale play of the North Texas Barnett field the fastest growing natural-gas field in the US.

On the unconventional oil side, heavy oil and oil shales were highlighted for greater research focus. Of the 5 to 7 tril-

lion bbl of in-place heavy-oil deposits estimated to reside in Canada, the US, and Venezuela, only 500 billion to 1 trillion bbl can be recovered with today's technology. In addition, these reserves are coupled with a large economic and environmental cost to produce, process, and transport. The authors envision major research needs and opportunities in the area of gasification, which converts the heavy-oil-processing byproducts of coke and asphaltenes into useful synthesis gas (syngas), a power source.

Conventional in-place hydrocarbons, a vast portion of which are left in the reservoir after primary-, secondary-, and tertiary-recovery methods, also deserve a major focus, according to the authors. "Increasing recovery efficiencies would supply much of the needed energy to meet demand into the distant future," they said, and they point to a well-known estimate by former Saudi Aramco Reservoir Manager Nansen Saleri, SPE, as proof. According to Saleri, a 10% increase in oil recovery translates to nearly 1.4 trillion bbl of reserves, which would supply current rates of global oil consumption for approximately 50 years (Saleri, 2006). The major R&D challenges to be addressed include better understanding of pore structure, faster well construction, more powerful electrical submersible pumps, and increased use of downhole automation.

The committee came to a consensus that increased energy diversification will be a necessary component of the energy offering over the next 25 years. Biofuels received the greatest focus as a hydrocarbon alternative in the paper, and the authors noted that major operators like Chevron, BP, and Shell have all formed research partnerships with universities and government entities to develop higher-efficiency cellulosic biofuels.

However, the committee noted that biofuels derived from corn, wheat, or sugar cane must be replaced with second-generation, nonfood feedstocks (algae, switchgrass) in order to make a positive economic and environmental impact. The necessary R&D will focus on methods "to improve biomass-conversion technologies, increase process efficiency, and enable suitability for industrial-scale deployment similar to current transportation infrastructure systems," according to Chevron's former chief technology officer Donald Paul.

As more than 80% of world energy supply is projected to come from fossil fuels during the next 30 years, the advisory committee noted that a significant R&D investment must be made to address environmental impacts, particularly with regard to CO<sub>2</sub> emissions. The committee highlighted carbon capture and storage (CCS) techniques as worth particular focus, and predictions indicate that up to 85% of CO<sub>2</sub> emissions from power plants, oil refining, and steel manufacturing could be removed from the air and stored underground in brine reservoirs or used for enhanced-oil-recovery operations. They caution, however, that more R&D will be needed before CCS technologies can be implemented fully, and that "national and international multidisciplinary teams consisting of engineers and scientists will be required, especially those with chemistry specializations."

"The R&D white paper was written in a way as to attract the attention of people outside the upstream oil and gas arena," said Judzis. "We wrote this with the idea that parts of it could be changed or expanded to attract interest from the business community, other sciences, and the public at large."

To that end, the committee has already written an article targeting the investment community, which was published in the February 2007 edition of *The Oil & Gas Investor*. In the future, the committee plans to write a more technical article for the scientific community at large.

### R&D Conferences Expand Themes

The current white paper was intended to set the stage for the first SPE R&D Conference. "We were not able to get the paper out before that conference, but we still felt it was important to publish it, as it covers the same major themes," said Rao.

"The sessions at the first conference were contemporary and fit some of the industry-wide thinking about what would be needed to capture the next trillion bbl of hydrocarbons," Judzis said. "The next conference will expand on this by including more dedicated discussion on alternative fuels and unconventional resources like shales and heavy oil."

The second R&D Conference, titled "Fueling the Future," will be held in Lisbon, Portugal, in March 2009. Rao, who will cochair the conference program committee, confirmed that more focus will be placed on a multidisciplinary approach using more unconventional energy sources.

"We will have two sessions with a theme of 'Unlocking the Molecules,' which was one of the most popular sessions from the 2007 conference," Rao said. "This time, we will break it into one session on hydrocarbon sources and one on nonhydrocarbon sources, which is a serious departure for the committee."

The conference will also include basic scientists from outside the E&P industry who have an interest in the challenges facing the upstream sector. "Dr. Steven Koonin, an eminent physicist who was provost at California Institute of Technology prior to accepting his current position as chief scientist at BP, has already agreed to give a keynote address at the conference," Rao said.

"His insight as a basic scientist who has pondered our problems for some years now will be especially instructive."

### Broader Committee Scope, Message

The need for contribution from scientists and energy sources outside the petroleum industry has become so important for the R&D Advisory Committee that it has changed its mission statement. "The new statement is a serious departure from the past," said Rao, "and covers more than just upstream R&D, because I do not think that upstream efforts alone are going to be sufficient to solve our energy problems."

The new mission statement is much more inclusive of unconventional hydrocarbon and alternative energy sources. "I believe energy companies are facing a future that has to include these sources," Rao added. "This goes to a view held by the chief executive officers of some of the supermajor operators, namely that there will be a plateau in production coming up, at

approximately 100 million BOPD. We are currently at 86 million BOPD, and by 2030, IEA estimates that we will need 120 million BOPD.

"Therefore, in my view, alternative fuels will not be an option, and the real questions will be how much and how soon," Rao continued. "While it will not happen tomorrow, our mission statement reflects that we at least need to start seriously researching this area."

The advisory committee is planning another initiative to spread the theme of fueling the future out beyond the 2009 conference. "I would like to see an upcoming series in the pages of the *JPT* titled 'Fueling the Future,' Judzis said, "in which we invite guest authors from all technical disciplines to discuss specific future energy challenges and how their research areas might address them."

Another committee initiative that will be informed by the remits put forth for collaboration and information exchange is SPE's R&D Technical Section (RDTs). Now in its second year of existence, the RDTs has a mandate to promote R&D in any area required by the upstream oil and gas industry. The predominantly virtual section is designed to let its 200-plus members meet online and via teleconference. The section's dedicated website is a place where interested parties can read R&D articles designed to spur threaded discussions, or share ideas and set up collaborations.

While there is little doubt that the industry faces some daunting challenges in producing the next trillion bbl, Rao is optimistic that these many initiatives will spur the necessary R&D. "Energy and energy problems are prominent in the news today. I believe that the more we get our message out, that we are trying to proactively address these problems through cutting-edge R&D, the better off we as an industry will be."

To learn more about the R&D Advisory Committee, its initiatives, and how to get involved, contact Rao at [vik.rao@halliburton.com](mailto:vik.rao@halliburton.com).

To read the R&D white paper in its entirety, visit <http://www.spe.org/sites/rd>.

### Reference

Salari, Nansen G., "The Next Trillion: Anticipating and Enabling Game-Changing Recoveries," *Technology Tomorrow, JPT* (April 2006) 58:4. **JPT**

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