THE QUEST FOR ENERGY: CHALLENGES OF DEEPWATER EXPLORATION

by

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Abstract

This paper discusses the current keen attention on deepwater exploration and production for hydrocarbon energy sources. It analyzes the factors and elements driving oil companies to enthusiastically engage in deepwater development activities. The features of such activities are discussed and the challenges faced by the oil companies to accommodate further expansion of activities in the field are outlined.

“It is clear our nation is reliant upon big foreign oil. More and more of our imports come from overseas.”

(George W. Bush – Beaverton, Oregon, 25 September 2005)

**Feeding the insatiable monster : The never-ending search for energy**

There are other oil-related, brainy-type quotes on the Internet that I could have easily used as an opening salvo for this paper, but I found the above too good to ignore. The quote offers drama and amusement, and arouse conflicting emotions at one serving, much the like the current oil market. While the second part, like many other Bushism classics, provides comic mileage for many TV talk show hosts, the first one offers a platform on which serious discourse on the current global energy situation can be built.

Reliance on oil is a significant factor in determining the direction of not only US foreign policies but many other countries. This dependence has driven some nations to unapologetically revert to ugly colonialist-like behavior to secure energy sources, and, as they stand accused, to even invade other countries, for lack of a more diplomatic description. Such is the lure of, in the Texas-size words of President Bush, *big foreign oil*.

As the world’s demand for hydrocarbon energy grows, the question of the adequacy of energy supply has been put into sharp focus. With oil price reaching all-time high levels and showing no sign of relenting, the world seems to be going on a panic mode in its search for new sources of oil to quench its insatiable thirst for energy. The race is on to ease skepticism and allay worries over the sufficiency of supply, and to bolster output to meet ever-rising global demand.

Current oil statistics are sobering, if not downright scary. The world now uses about 82 million barrels a day, translating into almost 57,000 barrels of oil every minute. According to International Energy Agency (IEA), crude oil demand would double in 25 years to more than 120 million barrels a day. Based on the average statistics of the major oil companies on global oil reserves, the world had about 1.93 trillion barrels of oil, but world production is seeing a current depletion rate of 1 million barrel per day.

While peak oil theorists are going into overdrive in painting a picture of gloom amidst the current high oil price anxiety, oil producers have gone on a counter-offensive to calm

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5 Peak oil theory, popularized by renowned geophysicist Dr M King Hubbert in 1956, predicted that US oil demand would peak around 1970. Initially scoffed at, the ‘theory’ stunned the world with its almost prophetic accuracy at the height of the OPEC oil crisis in 1971.
rattled nerves. Global energy demand is projected to sustain at a high level in the foreseeable future, hence cranking up the pressure meter for output to be increased. From a simple demand-supply standpoint, current output as reflected in reserves may not be sufficient as demand for energy is ever increasing. This has driven and will continue to drive oil companies to push the boundaries to explore and discover new energy sources in unchartered territories.

Apocalyptic prophesies notwithstanding, worries over peak oil and the energy demand-supply imbalance have never been greater. Given the anxiety in the current oil market, the pessimist’s voice is gaining currency. Talks of perilous dependence on oil and the need to start thinking about conserving energy and developing alternative sources are no longer rubbished. Amidst rising demand, persistently high oil prices and disruptive developments in major oil producing countries like Iraq, Iran, Venezuela and Nigeria, even the fiercest critic of peak oil theory will soon wake up to the realization that the world’s oil production may about to reach its peak – forever. When that moment comes, if it hasn’t already, some serious soul-searching about global energy consumption will be required, and near-panic efforts to strike oil on new terrains and territories, at land and sea, will send oil pumps working overtime.

Deepwater development: Plumbing to deeper depths

As energy is fundamental to the economic security and strategic interest of many countries, greater focus is trained on diversifying its sources of supply. Although renewable energy sources such as solar, wind and waves are increasingly playing an important role, their practical application, commercial value and reliability still leave a lot to be desired. In the foreseeable future, much of the world will continue to rely on fossil fuel to meet much of its energy demands.

Many experts believe that easily tapped sources of energy are already nearing full exploitation. This renders it necessary for new sources of energy to be identified and developed, leading to more challenging and expensive exploration of new frontiers. With declining production from near-shore sources and shallow ocean waters, oil majors have aligned their attention to oil resources in waters of greater depths.

Since oil exploration shifted offshore close to a half century ago, the pursuit has been carried out in deeper and deeper waters. Among industry players, deepwater connotes areas too deep to accommodate conventional freestanding steel platforms. Industry

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6 Royal Dutch Shell’s CEO, Jeroen van de Ven stated in 2005 that the world’s oil production was nowhere near peaking because of the potential of untapped reserves made economically viable by higher oil price. Whether his statement should be construed as a realistic expert’s prognosis or a questionable charm-offensive assessment is open to debate.

7 Take the Gulf of Mexico which has been a major supplier of oil and gas to the US for nearly half a century. As wells in its shallower waters are near exhaustion, focus has shifted to its deeper waters. Today, the Gulf is the world’s main focal point of deepwater oil and gas exploration, estimated by the US Department of Interior Minerals Management Service in 2004 to contain 56 billion barrels of oil equivalent.
standards categorize deepwater area as one with water depth between 200 meters and 1,000 meters, while ultra-deepwater area features depth beyond 1,000 meters. No doubt the definition of deepwater will test even lower depths with the exploration of deeper waters.  

IEA forecast that over the next 25 years, huge financial resources would be poured into finding new sources of energy. As an indication of the kind of money involved, an estimated $300 billion would be spent on energy exploration in Africa alone, mostly on oil and gas exploration development. On the back of huge and rising global demand, there is a pressing need to find more oil reserves in greensites such as deepwater, but oil exploration in such areas is very risky and very expensive. Industry estimates put the cost of drilling a deepwater well at between US$30 million to US$50 million, and the cost of developing a single deepwater field capable of exceeding US$1 billion.

Propelled by huge global energy demand, energy companies have gone into a frenzy to launch new deepwater and ultra-deepwater explorations, and some have struck gold, or rather, oil, with new discoveries. Spurred by the success, some companies are already positioning themselves to develop these frontiers further, and support service companies, particularly in FPSO (floating, production, storage and offloading) operations, are benefiting from the positive effect of the upbeat outlook in deepwater development.

How deep is your well? Factors driving deepwater exploration

While deepwater exploration is not by itself a terribly new pursuit, there is an unmistakable rash of oil majors venturing further offshore to find new oil sources. While there is no single dominant factor driving the ‘oil rush’ to unchartered territories out at sea, several noticeable trends and developments have combined to provide the impetus for oil companies to conduct deepwater exploration with gusto of late.

Rising world energy demand, on the back of rapid industrialization and economic growth of developing countries, has exerted pressure to the oil industry to step up production. There is serious global concern now that traditional oil sources such as the deserts of Middle East are fast approaching exhaustion, and that new sources must be found in

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8 Discoveries in waters deeper than 2,000 meters are not uncommon these days. In 2004, Shell set a then world record for the deepest producing field at 2,307 meters. As if that didn’t draw enough gasps, ChevronTexaco set a world record for exploration by drilling in 3,051 meters of water. See ‘Deep water: Where the energy is’ at the Minerals Management Service website at [www.mms.gov](http://www.mms.gov).


11 Minerals Management Service figures.

12 In Malaysia alone, there is a host of players claiming a stake in the deepwater sector, beside PETRONAS, the national oil company. They include Shell, Murphy Oil, Amerada Hess, Total and ConocoPhillips.
anticipation of their impending decline. There is a rising chorus of skepticism among analysts who believe that the world’s alternative sources of oil are inadequate to fill the gap should the production of the world’s major oilfields start to decline.

Ironically, the silver lining in the cloud currently hovering over the oil market comes in the form of providing a great incentive to search for new sources of oil, including in deepwater. Intensive activities are already taking place in the deep parts of waters such as the Gulf of Mexico, West Africa and the Brazilian offshore. It is estimated that oil and gas companies have only begun to explore half of the world’s known deepwater basins. The equivalent of a whooping 40 billion barrels of oil have already been found while another 100 billion are yet to be discovered. Based on this, deepwater indeed holds promising prospects to help allay fears of peak oil, not to mention whipping up excitement among industry players.

Developments in oil exploration and production (E&P) technologies have spurred more intensive search for oil in deepwater. Investment in upstream research to develop new technologies leads to oil majors gaining competitive edge to undertake the fiendishly expensive task of deepwater E&P. Cutting-edge technologies are now available and being extensively used in exploration to create images of deepwater basins, gather seismic data, and process and interpret information to great effect to strike oil in deepwater. Self-propelled drill ships and high-precision drills able to extend deeper ashore are being used and continuously improved on, enhancing the success rate of drilling. Better floating production and sub-sea systems, compliant towers and platforms currently in service help facilitate drilling and production in the harsh deepwater surroundings. Further R&D activities will result in even better technologies coming into stream to make those tasks more efficient and to help tackle even more challenging sites offshore.

Fundamental to the success of deepwater development is the spectrum of support services assisting it. Activities such as towage, anchor handling, fire fighting, pollution control measures, loadout, transportation and installation activities, and logistics support are crucial to support deepwater operations. New equipment and machineries are increasingly brought into play to overcome the challenges of operating in the hostile deepwater realm. They are being depended upon more and more to support the challenging deepwater surroundings and working environment. Better technologies have emerged in these sectors as the pursuit for oil ventures further ashore.

It’s not just about equipment and hardware, though. The ‘soft side’ of things also plays a crucial role in enabling deepwater activities to be pursued in an economically viable manner. State-of-the-art software has been developed in improving the design of

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13 Saudi Arabia, the world’s largest crude oil producer at 10 million barrels a day, is said to carry a quarter of the world’s known oil reserves. But analysts claim that its biggest fields in Ghawar and Abqaiq are fast approaching exhaustion, and it has been decades since Saudi last discovered a giant oil field.


16 Ibid.
deepwater tools and technologies to boost the economic viability and operational success of deepwater development. Advent in reservoir management such as in the field of modeling to simulate the performance of deepwater reservoirs helps oil majors make accurate decisions on this challenging and expensive pursuit.

The rise of China deserves a special mention as an indirect factor fuelling the current excitement surrounding deepwater ventures. The rise of this economic superpower-in-waiting is often mentioned by economists and energy analysts as the foremost reason the world energy demand and oil prices have risen sharply. As the country goes on an astounding economic development binge, its demand for energy to power its economic growth has risen just as dramatically. The need to secure energy supply has become a matter of strategic interest to China, which now imports an estimated one third of its energy needs and has emerged as the world’s largest oil consumer after the US.\(^{17}\) The country is expected to consume 120 billion cubic meter of natural gas annually by 2010 but would be able to produce only 80 billion cubic meter per year domestically.\(^{18}\) Such shortfall underlines the acute need for China to secure its energy security as its economic juggernaut rolls on and its energy consumption grows in tandem. In line with this, China is deepening its relationship with the Middle Eastern region, its traditional imported energy source, and is increasingly getting more engaged with other regions like Africa and Latin America to meet its energy needs.

‘Energy diplomacy’ is gradually playing a more significant role in charting China’s strategic maneuverings and foreign policy direction. Further accentuating its emphasis on securing energy sources, China has been engaged in potentially adversarial face-off with several nations. It has joined a chorus of claims by several nations of the Spratly Islands, a group of islets, atolls and reefs in the South China Sea believed to have enormous reserves of oil and gas. It has also entered into a dispute with Japan over the Diayou / Senkaku Islands which are also reputed to have extensive natural gas reserves, and both countries are locked in fierce negotiations to sort out territorial rights over energy sources.\(^{19}\) The national energy company, China National Offshore Oil Corporation (CNOOC), attempted a failed bid to acquire US energy company, Unocal. Despite tensions arising from China and India’s power projection and assertive posturing, Sino-Indian energy cooperation has increased, as evidenced by joint investments in oil projects in Iran and Sudan, and by the alliance between China Gas Holdings and Gas Authority of India Ltd.\(^{20}\) All these are testimony to China’s seriousness about securing its energy needs.

Yes, let us not forget about India. Together with China, the Asian Big Two’s breakneck economic growth and rising clout as world powerbrokers suggest that they will be on a serious pursuit for new sources of energy to power their economic engines. As their own

\(^{17}\) According to IEA, China’s energy needs accounted for 40% of the total growth in global oil demand over the last five years. It is projected to import two-third of its oil by 2025.
\(^{19}\) ‘Japan, China to hold informal talks on ties, energy’, www.bloomberg.com, 6 January 2006.
domestic productions do not come close to fulfilling their ravenous energy needs, China and India will depend even more on imported oil and will continue to build their strategic oil reserves. These developments, among others, look set to fuel growing global energy demand and provide the impetus for exploration for energy in far-flung locations, deepwater included.

**R&D : The backbone of deepwater exploration**

As the ocean gets deeper, pressure increases, temperature drops and ocean floor gets harder. Further ashore, currents and waves can reach the heights of multi-story buildings. All these elements conspire to make the deepwater environment a challenging one. As such, hardy, efficient equipment need to be deployed to deal with the hostile elements dished out by the deepwater environment to get the job done.

Technology is the lifeblood of the oil industry and the key to the competitiveness of oil majors, and its role in deepwater E&P is paramount. While oil-soaked men and women working the pumps and drills on deepwater platforms present the most enduring image of the pursuit, the scientists and technicians doing research and development (R&D) in supporting upstream deepwater operations behind the scene play just as crucial a role.

Oil majors invest huge amounts of money in R&D to develop advanced technologies to give them and their partners a competitive edge in a fiercely competitive industry. Such development includes creating computer models of deepwater platforms to ensure robustness of their design, and to determine the production systems to carry out deepwater works. Through R&D, new deepwater discoveries are effectively evaluated, helping oil companies to find ways to produce more oil at lower costs from the wells. New models are continuously researched and developed by oil majors to subject deepwater structures to stress and motion tests to boost their integrity and sturdiness.

Much sub-sea work in deepwater development is carried out by robots and via remote control. The use of remotely operated vehicles (ROV) controlled from vessels on the sea surface at deepwater sites is common. Deepwater ROV are of a wide range, from those carrying tiny down-hole service tools such as video cameras to mammoth maintenance vehicles used to accomplish complex maintenance tasks. In developing robotic technologies and automation to facilitate such functions, huge amount of capital has been invested into R&D activities. While the amazing systems and machineries seem to be ubiquitous and taken for granted in today’s deepwater operations, they represent a triumph of technology and of the dedication of the people working in R&D.

R&D is just not confined to find deepwater oil wells and support operations, but also to forecast the performance of reservoirs, sometimes up to decades. State-of-the-art modeling software and tools are used in reservoir management to pinpoint the resources, select the location of wells and project their depletion rate. They boost the success rate of deepwater development, playing a critical role in justifying the significant capital investment that comes with the endeavor.
Research is underway to develop new and better technologies for drilling in deeper waters, reportedly reaching 3,000 meters (10,000 feet). Such depth will involve technically complicated and impressive feats such as drilling extensions off main wells and horizontal drillings. Deepwater work also demands great flexibility in terms of rig utilization and drills to find the perfect match with one another. In the quest for deepwater oil, nothing is impossible, and impossible is nothing indeed.

**Deeper water, greater challenges**

Technology will continue to be at the forefront of deepwater E&P and will play an even greater role in improving the amount of hydrocarbon recovery and in support of its production in greater depths. Better exploration techniques and assessment of data will be required to yield new finds in unexplored offshore regions to discover new deposits. The role of technology in enabling oil and gas companies to extract new deepwater reserves will become even more crucial in the future.

Given the pressure to find new oil sources, improving technologies and the lucrative prospects of returns, more discoveries in previously undiscovered territories around the world will be made, in addition to those already earmarked for development. Several upcoming production areas located in even deeper waters will present daunting but exciting challenges to the oil industry and its support service providers. Such demanding pursuit will require the use of better technologies, greater capital commitment and better management and manpower skills from all involved.

In the waters of developing regions such as Asia, Latin America and Africa, new technologies will be required to recover deposits from such depth, in activities such as the drilling of wells and installation of sea-bottom facilities. An able support base is essential to prop up the kind of challenges that will come with installing, operating and maintaining facilities at remote locations, while observing the need to be cost-effective.

The Chief Financial Officers of oil majors can vouch that as their companies venture into deeper waters, they need to dig deeper into their pockets. Costing up to US$50 million to develop, deepwater wells are a mighty serious, major capital investment. Being able to drill them is not good enough - there must be economies of scale and ensured profitability. To achieve this requires operators who can plan well ahead and ensure optimal development and production performance. Deepwater development is not for the financially faint-hearted, and will not likely become cheaper anytime soon. Only the ExxonMobil and the Shells of the world have the financial strength to underwrite and sustain major deepwater projects. It is therefore foreseen that host countries without strong state-owned oil companies will more and more align themselves with giant multinational oil majors with huge resources and strong balance sheet to exploit their deepwater sites. Production sharing contracts (PSC) of deepwater acreages will have to be carefully mulled over to ensure they are awarded to financially and technically capable partners to ensure optimal success.
As global appetite for hydrocarbon energy continues, led by the economic boom in developing countries such as China and India, it is crucial that the supply side matches the demand side. For supply to keep up, investment must be poured into finding new sources of oil. The industry went through a period of under-investment in the 1990s and is still suffering its effect, as seen in the current shortage of infrastructure such as rigs, platforms and tankers. For deepwater development to thrive further, this situation needs to be addressed as deepwater ambitions cannot be realized without adequate investment in infrastructure and support services to match.

Challenges await oil companies not only to discover new deepwater sites but to improve existing technologies and harness new ones to facilitate the development of existing reserves. As the amount of oil likely to be extracted from new deepwater fields depends to a large extent where they are drilled, it is critical for oil companies to design the right strategies and deploy the right tools to yield the most optimal value from the wells. Lucrative returns await companies that can develop cost-effective E&P solutions and to shorten the time between discovery and production, and to delivery to the oil market. They must also contain the huge costs involved in the commercialization of deepwater resources and do so in the most cost effective manner.

While several deepwater areas have been recognized as having huge oil reserves, there are many smaller opportunities in other regions that could be attractive. Under-explored deepwater territories such as parts of the North Atlantic, Mediterranean, Caribbean and South East Asian waters are deemed to have potential and will attract interest and investments. Oil companies will face the test of exploiting these sites to maximum commercial effect to realize attractive margins and sustainable returns from the huge capital outlay.

Despite recent record-breaking profits and high oil prices, oil majors will continue to be subjected to intense pressure from investors seeking a quick return and from aggressive state-owned oil corporations competing for market share. This puts oil companies in a paradoxical position of enjoying huge cashflows but limited earnings opportunities due to mismatch of short-term financial obligations and long-term growth strategies. If such pressure continues to build, it can have an adverse impact on their investment allocation for deepwater development.

There are also several environmental issues that should not be shoved aside amidst the euphoria over deepwater E&P. They include, among others:

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23 Analysts have observed that state oil companies frequently come under pressure to transfer more and more petrodollars to governments, hence eating into money for investments in E&P. See Robinson, M., ‘Reuters Summit : Oil price may hit economic growth – Bodman’, Reuters, 24 May 2006.
24 As identified by the Deepwater Subcommittee of the Outer Continental Shelf Advisory Board’s Scientific Committee, a body which advises the Mineral Management Services (MMS) in identifying and prioritizing its deepwater information needs. MMS, a bureau in the US Department of the Interior, is a US
• Socioeconomic impacts on ports and coastal support activities.
• Storage, handling and discharge of chemicals and drilling mud.
• Avoidance of fragile deepwater organism communities.
• Potential problems caused by gas hydrates during operations.
• Effects of deepwater blow-outs and pipeline leaks.

Amid their enthusiasm to make hay while the sun is shining, oil companies must practice good corporate citizenship by working with relevant authorities and stakeholders to address such issues and emerging ones. Towards meeting this objective, they should especially allocate resources to fund research activities and strategies to address critical environment concerns over deepwater development activities.25

The need to conserve resources should also be given attention to. Thus far, deepwater is always associated as an oil-producing region, but the need to explore gas as an alternative, environment-friendly source of energy should not be ignored in the search for ‘black gold’ from the area. Oil companies should also pursue strategies and develop technologies to promote natural gas recovery in the deepwater province just as enthusiastically as they do with oil.

Human dimension issues emerging from working in the testing deepwater environment will also continue to confront oil companies. The close-quarter nature and the remoteness of the area require the brave men and women who work there to do so in a safe and acceptably comfortable surroundings. Their companies should strive to cater to their physical and mental well-being in such harsh, unforgiving conditions. There are various occupational safety, human resources, social, environmental and technological issues that must be addressed towards creating a tolerable environment for deepwater installation personnel.

**Going deeper, looking further**

As the world’s energy consumption continues unabated, the drive to search new sources of oil will gain more momentum. As new oil fields are discovered, with deepwater leading the way, more supply should be on the way, albeit taking some time.26 With the know-how and tools at hand, plus ever-improving technologies, there is no reason not to be optimistic about the prospects of deepwater development. As it stands, the outlook for

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25 In the US, DeepStar Consortium, an oil industry grouping formed to address the technological challenges posed by deepwater operations, engages the government, industry and the scientific community in the area of technical research and operational requirements. Perhaps the same model could be used to form a similar grouping to address deepwater environmental issues.

26 Industry estimates put the time gap between a new oil discovery and production at about 10 years.
deepwater development is unmistakably bullish, as evidenced by the intensity of the activities in this domain.

But the deepwater is nothing if not daunting. Although people in the industry are renowned for their can-do spirit, some industry experts believe that current oil prices and technical challenges are not that detrimental for deepwater prospecting, but are more concerned about the physical limitations of the potential sites. If that is the case, geophysicists will face the challenge of identifying new deepwater wells with active petroleum systems that are economically viable to tap into, to a comfortable degree of accuracy.

As the quest for energy advances into even deeper waters, new issues and greater challenges will continue to emerge on many fronts. Given the many yet unknown resources awaiting in the deep blue sea and the uncertainties over the elements surrounding its environment, deepwater E&P activities must be conducted with the utmost vigilance and a sense of responsibility. A deeper understanding of the deepwater realm must be developed before it can be exploited. Existing technologies such as ROV and remote sensors should be fully deployed to appreciate its elements, understand its sensitivities and value its resources, before dispatching the all-conquering troops and their tools to the deepwater frontier.

An even greater task for the stakeholders in the oil industry than conquering the elements and confronting the challenges of the deepwater is to respect and protect its environment. More than just being concerned about extracting big foreign oil, deepwater operators should develop the conscience to extract mother nature’s abundant resources in a sustainable, responsible manner.

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27 Chandler Wilhelm of Shell Oil was quoted as saying during the AAPG International Conference and Exhibition in Cancun, Mexico in October 2004 that from a water depth standpoint, the ultimate limitation will be “geological, not technological”. If this could be taken as the gospel, it is foreseen that the level of bullishness towards deepwater development would be driven more by the geological features of deepwater sites rather than the technological challenges they pose.