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Deepwater Developments in Angola[1]

Angola is a key player in Africa's oil industry as both a major producer and exporter. It accounts for 3.5 % of US oil imports overall and is the 7th largest supplier of oil to the U.S. New discoveries are adding reserves faster than existing reserves are being depleted. Angola leads the world's oil producing countries with a 583 percent replacement rate. Since 1996, significant discoveries in offshore Angola have emerged one after another, making it the hottest exploration spot in the world. Fast pace development will soon make the country producing 1 million barrels of oil per day. There is growing interest in Angola's remaining deepwater blocks.

- *What is the status of exploration and development in offshore Angola?*
- *Why offshore Angola became exploration hotspot?*
- *What are the implications of Angolan oil on world oil supply markets?*

Background

Angola is sub-Saharan Africa's second largest oil producer behind Nigeria and the first in deepwater discoveries and development. It has a population of over 10 million, and an annual growth rate of 2.84%. Hundreds of thousands of people have been killed in the post-colonial, civil war between the government and the National Union for the Total Independence of Angola (UNITA) since it achieved its independence from Portugal in 1975. Since the civil war has severely crippled its non-mineral sectors of the economy, Angola is an economy in disarray and highly dependent on its oil sector, which accounts for 60% (in 1999) of the country's Gross Domestic Product (GDP) and nearly 90% of government revenues[1]. Due to its booming oil sector, Angola's economy grew by 2.1% (real GDP growth rate) in 2000 and is expected to grow an additional 3.3% in 2001[1]. However, inflation is still high in the

[1] This case study was prepared using publicly available information.

country from 325% in 2000 to the estimated 128% this year[1]. The majority of its population is still living in poverty.

To help the country avoid serious squandering of oil money like some African countries, the IMF conducted a nine-month economic monitor program and concluded that the Angolan government has made progress in several areas including price liberalization, exchange rate stability and cutting down inflation[1,2]. This assessment and the expected 2002 or 2003 president election will attract more international investment and further its economy.

Exploration

Most of the exploration activities in Angola have mainly focused on the Lower Congo Basin deepwater area since 1996, and have demonstrated that this is an extraordinarily prolific hydrocarbon province. The majority of discoveries have been found on Blocks 14, 15, 17 and 18, including several giant fields (>500 million barrels of oil).

In the ChevronTexaco held Block 14, seven fields have been discovered as of now. Based on these discoveries, Chevron estimates that Block 14 has recoverable reserves of more than 3 billion barrels[3].

ExxonMobil is the operator of Block 15, which is next to Block 14 to the south, with an area of 4,000 sq km. ExxonMobil has made 13 oil discoveries on the block since the first oil field, Kissanje, was found in February 1998, with discoveries continuing to the present. Block 15 contains recoverable reserves of more than 3.5 billion barrels[3].

Block 17 was one of the first Angolan deepwater tracts Sonangol offered to the industry in 1991. Elf became operator of the block. Seismic work was done on this 5,030 sq km block in 1993 and first well was drilled in 1994, which had oil and gas shows but the well was not tested. The second well was drilled on the giant structure named Girassol, which turned out to be a huge success. Oil was found in Tertiary Malembo Group sandstones, which comprise three main reservoirs with an interval of 95m. Test showed that good quality oil coming from the upper pay zone, B_3, flowed at a restricted rate of 2,800 b/d. The twin appraisal wells drilled in 1996, which on test flowed 14,000 b/d from B_3 sandstone, further delineated that Girassol Field is a giant field with more than 700 million barrels of oil.

TotalFinaElf found its second discovery on Dalia structure in 1997. The first well, Dalia 1, encountered two Tertiary Malembo sandstone intervals, testing 16,000 b/d from both of them. The second well Dalia 2 and two other appraisal wells confirmed that Dalia Field has recoverable reserves of 800-1,200 million bbl. However, the field's 22°-23° API Miocene oil is significantly heavier than the 32° API Oligocene oil in the Girassol Field. The third big discovery is Rosa (1998), with a test rate of 12,000 b/d and the same quality of oil as the Girassol Field. Both Dalia and Rosa have the potential to be bigger than the Girassol Field.

Other discoveries found by TotalFinaElf on this block are Lirio (1998), Tulipa (1999), Orquidea (1999), Cravo (1999), Camelia (1999), Jasmim 1 (2000), Perpetua (2000). The latest two are Violeta and Anturio, which are found in 2001 but carry tight-hole status. In total, 12 discoveries on Block 17 contribute an estimated recoverable reserves of somewhere between 3 and 3.5 billion bbl[3] making TotalFinaElf the leading company among those competing in the Angolan offshore arena in terms of size of individual giant fields and number of the discoveries.

Block 18 is less significant compared the above-mentioned three blocks in terms of discovery numbers and tested flow-rates, but operator BP Amoco has already found 6 discoveries on this block with six wells. The first discovery, the Platina Field, was found in early 1999, which tested at 6,500 b/d. Then came the Plutonio Field, which tested at 5,700 b/d. The two fields are expected to harbor as much as 500 million barrels of oil[3]. The Galio Field was found in 2000 with flow-rate of 4,700 b/d, and then the Paladio, Cobalto, and Cromio Fields

in 2000. Obviously Bp Amoco has been doing well in terms of the exploration success rate on this block, but whether Block 18 contains the predicted reserves of as much as one billion barrels of oil or even more remains to be seen.

Other awarded deepwater blocks include Blocks 16, 19, 20, 21, 22, 24 and 25. Much more exploration work is needed to tap the potential resources in these blocks. Shell's work showed that Block 16 was a complete failure by having drilled a total of nine wells without making a single commercial discovery. The acreage, which was believed to hold about 155 million barrels of oil, was relinquished in June 1999 and reopen now[4]. A new consortium led by Texaco is said to be interested in taking over the block. The other blocks are at their various stages of exploration with only one find in Block 24 being reported, which was Semba-1 drilled by ExxonMobil and encountered two oil-bearing reservoirs that flowed at a combined test rate of 3,039 b/d.

Ultra-deep water is also an attractive area for exploration. Blocks 31 to 34, which lie just to the west of prolific Blocks 14 to 18, are expected to hold even greater potential by analogy of the rich Brazil's Campos Basin on the other side of the Atlantic and by their adjacent, already proven fields. The four blocks licensed in 1999 by BP Amoco were, TotalFinaElf, ExxonMobil and Sonangal, respectively. For Blocks 31 to 33, blanket 3D seismic surveys have been done and BP Amoco has already logged two discoveries on Block 31[3]. Major exploration work will be conducted over the next two years.

Even though the fast-track exploration activities are in offshore Angola, there is still plenty of room left for drilling wildcats in deepwater and ultra-deep waters. There are still many blocks waiting to open up currently Blocks 28 to 30 and ultra-deep blocks 35 to 48 are in that situation. These are blocks in Kwanza Basin and blocks lying to the west of Blocks 31-34. But whether there is a rush towards these blocks remains to be seen, because these blocks are geologically more uncertain, technologically challenging, and financially demanding for independents, while super-majors already have a full portfolio of deepwater blocks and there are signs that at least one major company has already slowed down the pace of activity.

Development and Production

Apart from the exploration successes, the development on several giant oil fields also captured the industry's attention. The Kuito Field in Block 14 was the first deepwater field put in production in Angola. Using a phased developing approach, Phase 1A started in September 1998 and Phase 1B began in May 1999. By the end of 1999, all work had been completed, making the Kuito Field the fastest cycle time of any project of its kind ever in West Africa—only 15 months after award of the contract.

The Kuito Field Phase 1C development has been finished, successfully producing oil. The new phase has added more than 30,000 barrels of oil per day, bringing current daily production from the Kuito Field to approximately 85,000 barrels of oil. Average daily production for Kuito in 2002 is expected to be approximately 66,000 barrels of oil[5]. The production is via the 1.4 million-bbl-capacity FPSO Kuito. Other fields on Block 14, Belize and Tomboco will be developed jointly, and the Tomboco Field will probably be tied into the same production facility.

The fast-paced development of the Kuito Field by ChevronTexaco certainly inspired other companies to follow suit. Perhaps the most high-profile deepwater development in offshore Angola is the Girassol Field, which has estimated recoverable reserves of over 700 million barrels and lies in 1350m of water. It will be developed using a sub-sea facility tied back to an FPSO, which is the largest FPSO in the world, with a storage capacity of 2 million barrels.

TotalFinaElf began to develop the Girassol Field in 1998, and expected to put it into production at the end of 2000. However, starting date was put off one year due to technical prob-

lems. To date the FPSO is in position and several development wells of its schemed 39 wells have finished. First production was brought on stream at the end of 2001 producing 200,000 b/d and will maintain that level at least four years. This means that the deepwater fast production build-up is not possible, especially under the current oil prices. But by the mid-2002, oil production in Angola will probably past the 1 million b/d mark, a delayed objective of Angolan government.

Another world-class development project is Kizomba A on Block 15. On August 24 the ExxonMobil Corporation announced that its subsidiary, Esso Exploration Angola Limited, has started construction of the largest deepwater development offshore of West Africa. The project will include the combination of a surface wellhead platform and a sub-sea production system tied back to what will be the world's largest Floating Production, Storage, and Offloading (FPSO) vessel. The FPSO will have a 2.2 million-barrel storage capacity. First oil is scheduled for late 2004 with a target production of 250,000 b/d, and the recoverable reserves from Kizomba A are estimated as much as 1 billion barrels.

Other development projects on drawing board includes Dalia and Kizomba B. Dalia's reservoir could yield 1 billion barrels of oil, but the value of Dalia's relatively heavy oil is less than Girassol's, which is certainly a factor in considering the starting date. TotalFinaElf expect contracts for the facility to be awarded early next year. Dalia's first oil is scheduled for the first half of 2005, and the target production is 225,000 b/d.

Kizomba B is the second phase development plan for Block 15. Hoping to cut costs and cycle time, ExxonMobil promoted the concept of "design one, build two"; But Sonangol has not yet agreed to the concept. If the plan for Kizomba B is approved and start to build concurrently with Kizomba B, it will probably be put in production in 2006.

Natural Gas development

Angola has rich natural gas resources. It is estimated that Angola could possibly have natural gas as high as 25 Tcf[1]. This would not be a blessing for Angola if no measures were taken since 85%of gas production is flared currently. Fortunately, a consortium led by ChevronTexaco has agreed to develop a LNG project that would convert natural gas from offshore oil fields to LNG for export[1]. This $2 billion project began in 2002 and will be put on stream in 2005, processing 4 million tons of LNG per year. That will accommodate gas from Blocks 1, 2, 3, 4, 15, 17 and 18. If further fields come on line through 2010, expansion of the facility may be needed for year 2010 has been chosen as the target for zero gas flaring[6].

Attractions

Exploration in deepwater Angola is attractive for a number of reasons and it is these reasons that eventually drive offshore Angola as hot exploration province. First of all, it is a new frontier and geologically belongs to the Lower Congo Basin and the Kwanza Basin, which are parts of the Southern Atlantic passive continental margin basin. Although the petroleum industry in Angola is almost fifty years old, and its state oil company, Sonangol was established in 1976 and acted as the sole concessionaire for oil exploration and production in Angola, it did not open up its deepwater acreages until early 1990's. Although the past several years of fast-track exploration have found huge reserves mostly in Blocks 14, 15, 17 and 18, there are still significant areas undrilled. Even in blocks where exploration has finished, there are still possibilities adding new fields. Relatively shorter exploration time and capital constraints are also factors keeping the area an unmatured one.

Secondly, the past few years of exploration mainly conducted by consortia of international companies along with Sonangol has demonstrated that deepwater Angola harbors giant fields. Average field reserves are 200 million barrels. This means offshore Angola is a geologically favorable province. Besides the contribution of 3D seismic data, the astounding exploration success rate indicates that geological risk is low. To date, all discoveries are struc-

tural or combined traps, meaning there are still plenty of opportunities for searching subtle accumulations and possibly sub-salt targets implementing sequence stratigraphy and salt tectonic theories.

Thirdly, the Angola government has been constructive in doing business with international oil companies and has responded to outside exploration interests by revising hydrocarbon laws, opening acreages, and being flexible in cooperation. Driven by the need of oil revenue, fiscal terms in Angola are among the most favored for operators, and Angola is one of the few countries that awards leases on the trend of discovered fields.

Fourthly, the ocean environment is benign. Although operating deepwater is never easy, relatively calm seas and light wind allow drilling in deeper waters using the same technology. In addition, offshore production is away from onshore conflict areas. Oil can be easily shipped to destinations without much influence from the country's civil war.

However, there are several disadvantages that must be taken into consideration. Politically, government corruption, financial mismanagement and human rights abuse are major problems. Technologically, exploration and development costs are huge. A deepwater well typically costs $20 million to drill, and as mentioned before, development cost is high as well. In order recover the high initial investment; large reserves and high flow-rates are needed. In a stand-alone development mode, a justifiable production number is not far below 10,000 b/d. This certainly is a severe constraint for small and scattered fields. Furthermore, long distance transportation of oil increases the costs due to a locally weak economy.

Implications of Offshore Angola Oil

Exploration in offshore Angola is extremely expensive especially for small companies, requiring a lot of up-front investment. That perhaps is the reason why only major companies operate there. The great successes in the past several years might drive signature bonuses even higher for the remaining blocks. However, the rewarding side of exploration is the potential for huge reserves. For instance, average exploration costs for block 17 are estimated at 20 cents a barrel—among the lowest recorded anywhere in the world[7].

Development costs are huge too. ExxonMobil's development projects on Block 15 are going to cost more than $6.4 billion. Kizomba A, which now is underway, will cost $3.2 billion alone. ChevronTexaco is going to invest $6 billion over the next five years in its block 14, including the $2.1 billion Kuito development. To put the Girassol fields on stream, TotalFinaElf needs $2.5 billion investment, and perhaps even more for Dalia development. Capital expenditures, assuming all the fields on Block 17 are developed, could top $8 billion[8]. Totally the influx of investments is going to reach $21 billion in 2006. Again, big recoverable reserves justify such investment for development costs should be kept under $4 a barrel for deepwater fields to be profitable[9].

All the on-going developments in deepwater Angola are planned to produce oil around 2005 and 2006. According to analysts at Douglas-Westwood, West Africa will supply 21% of all offshore oil reserves brought on line and West Africa's success coincides with the prospect of declining output in the major producing areas, such as the shallow waters of the Gulf of Mexico (GOM) and the North Sea[10]. However, North Sea oil production just reached its peak exceeding 6 million b/d in 2000. And it is not going to drop off dramatically in the very near future[1]. GOM's production will continue rising in the near future even at relatively slow growth rates. Therefore, due to the low costs of offshore Angola's production, 1.5 million b/d in 2005 or 2006 might have certain negative impact on the production in GOM and North Sea, especially when oil prices are low. OPEC's remote hope that Angola might join in a non-OPEC supply cut recently did put the country on a position that could tip the balance of world oil supply and demand.

In nutshell, exploration in offshore Angola has been tremendously successful and encouraging, and development activities are also in full swing. Without severe political events, Angola will soon be a major deepwater producer, reaching 1.5 million barrel per day in 2005-2006.

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