CHAPTER 5

World Oil and Gas Production

Now we focus on the world's oil and gas major producers (OPEC and non-OPEC) from an export perspective. We detail the dominant oil companies behind world exports as well as each country's production level, reserves and capacity.

Although conventional oil production and reserves are globally dispersed, the highest concentration is in the Middle East. Since the 1960s, this region averages nearly 30% of total global oil production and controls 61% of world oil reserves. OPEC itself produces 43% of world oil production and controls 75% of proved oil reserves. Of the 15 countries worldwide that produced 2 MMbbl/d or more of total liquids for export, seven were OPEC members[1].

The Oil Is Ours

Any consideration of OPEC must begin with its' importance as a reserves holder and major oil exporter. From this perspective, only producers that export more than 1 MMbbl/d to the global markets are considered (net of any imports for national refining or consumption). Net exporters play an extremely important role in satisfying demand in global markets because their oil supplies are real exports over and above their domestic needs and are therefore known sources of future oil supply.

Every Move You Make

Undoubtedly, every move made by OPEC gets as much headline ink around the world as any Central Bank decision. It is watched by the major press agencies who have assigned some of their brightest minds to cover the decisions that usually come

out of the Austrian capital. Sitting permanently as an inter-governmental organization, OPEC has 11 members: Algeria, Indonesia, the Islamic Republic of Iran, Iraq, Kuwait, the Socialist People's Libyan Arab Jamahiriya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela. The combined population of OPEC countries is just over half a billion people and most are dependent on oil revenues for sustaining their economies. For these countries, oil is the platform for economic, social and political growth[2].

OPEC currently produces about 43% of the world's crude oil, but that is forecast to grow to more than 50% in the next quarter of a century. OPEC has 75% of the world's oil reserves and this will enable it to expand oil production to meet the growth in demand. In order to expand OPEC output, the oil industry needs the oil price to remain at a profitable level. Oil producers invest billions of dollars in exploration and infrastructure (drilling and pumping, pipelines, docks, storage, refining, staff housing, etc.) and a new oil field can take three to ten years to locate and develop. Commercialisation and profitability are complex issues which are dealt with—in the next Chapter[3].

All OPEC countries are sensitive to oil-price fluctuations because of the large contribution oil revenues make to state coffers. As one would expect, high oil prices yield larger gains in revenues from oil exports; the opposite is also true.

Before getting into detail about the major OPEC exporters of oil, it is worth mentioning the Gas Exporting Countries' Forum (GECF). This forum was formed in Teheran, Iran in 2001 with a view to managing global gas reserves and providing a stable and transparent energy market. The GECF consists of 15 gas-producing countries: Algeria, Bolivia, Brunei, Egypt, Equatorial Guinea, Indonesia, Iran, Libya, Malaysia, Nigeria, Qatar, Russia, Trinidad and Tobago, the United Arab Emirates and Venezuela. Five of these countries—Russia, Iran, Qatar, Venezuela and Algeria—control nearly two-thirds of the world's gas reserves and account for 42% of its production. The GECF has a liaison office in Qatar which is 'formulating a gas-trading model to share knowledge of supply and demand and create a level playing field in negotiations with international operators'. It is likely that the GECF will become a gas OPEC. Russia has offered to permanently host the organisation at the most recent meeting in Moscow where Equatorial Guinea and Norway were attending as observers[4].

Saudi Arabia

Saudi Arabia produced a daily average of 10.4 million barrels of oil (MMbbl) in 2007, consumed 2.15 MMbbl/d and exported 8.25 MMbbl/d.

Famous for its ability to 'swing' world markets into 'equilibrium', Saudi Arabia is commonly recognised as the world's leading oil exporter. It sits atop a quarter of world oil reserves, a fifth of international exports and more than a tenth of total world production. It has a refining capacity of 3 MMbbl/d. One of the Kingdom's goals is to maintain sufficient spare production capacity so that it can stabilise the market in a given situation. Leaving production capacity idle, and therefore forfeiting revenues, is commendable on the part of Saudis. Whether such ability continues to exist, and averts the energy crises resulting from supply level, will be dependent on investment in refining capacity and technology.

Geology

The Saudi Geographical Survey identifies the Phanerozoic cover as the geologic range of interest for oil and gas reserves. The Phanerozoic ranges from the Saudi Arabian Paleozoic (540-250 millions of years ago [Ma]) to the Cenozoic (65 Ma to recent) and it crops out as relatively flat beds of sedimentary rocks such as sandstone, siltstone, limestone, evaporites (salt deposits), and volcanic rocks. The youngest deposits in the region include coral limestone and unconsolidated sand, silt, gravel and sabkhah, which accumulated in the sand seas of the Rub al Khali and An Nafud and were deposited on to dried-up lake beds, valleys (wadis) and coastlines.

Reserves

Estimates place Saudi Arabia's proven reserves by the end of 2007 as at least 264.2 billion barrels including new finds and the mega-projects listed below. This is a consensus figure based on the inclusion of probable and possible reserves based on the Society of Petroleum Engineers (SPE) reserves criteria[5].

Although there has been recent speculation of a lower volume of reserves primarily due to watercut, this is a red-herring as the occurrence of increased water production and re-injection are standard reservoir conditions and secondary recovery mechanisms. This is discussed more fully in *Chapter 9: Mature Fields*. Based on current reserves data, it is fair to say that the last barrel of oil will likely be from Saudi Arabia.

Saudi Aramco

Saudi Aramco is the modern day legacy of the Arab American Company. It is as technically sophisticated and diverse as any major oil company with approximately 86% of its staff as Saudis and the remaining 14% employees from more than 50 countries. Saudi Aramco has invested heavily in reservoir and E & P technology and runs one of the world's largest carbonate research centres encompassing reservoir modelling, dynamics and visualisation. Contrary to the popular belief that low-cost onshore environments have limited technology applications, Saudi Aramco runs the latest in downhole drilling and completions technology such as rotary steerables, high-end logging and formation evaluation tools as well as maximum reservoir contact wells (see *Chapter 7: Pregnant Ladies and Fish Bones*). The company's flagship Research and Development Centre (R&DC) employs 350 research staff working on seismic, drilling, completion and production projects[6].

In spite of the recent surge in its oil income, stabilisation funds and foreign investments, Saudi Arabia is seeking to diversify its industrial and financial base beyond petroleum and has initiated several knowledge and industry based projects such as the King Abdullah University of Science and Technology[7].

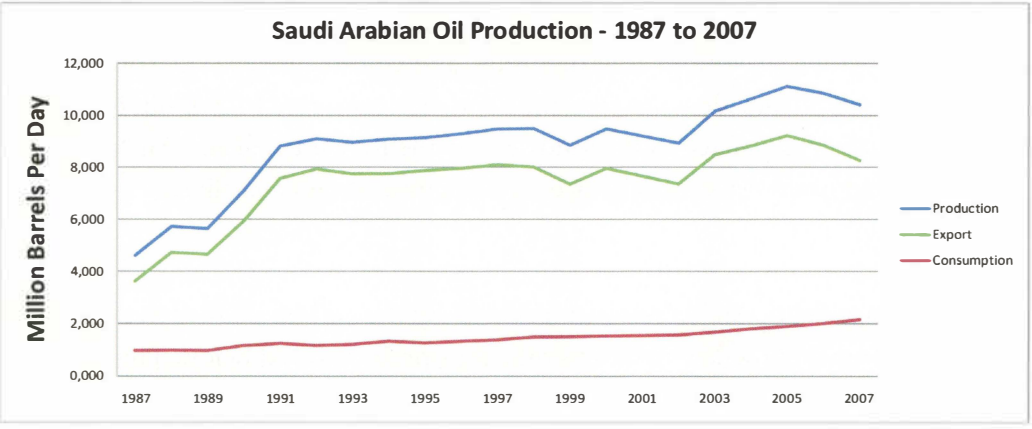

Table 1 - Saudi Arabian Oil Production (1987 to 2007)

Iran

Iran produced 4.4 MMbbl/d through 2007. It still made net oil exports of 2.78 MMbbl/d considering that Iranian domestic oil consumption was 1.62 MMbbl/d[8].

Iran's oil and gas sector is dominated by the National Iranian Oil Company (NIOC). Foreign companies are active in Iran and include Gazprom, Japanese National Oil

Company (JNOC), PETRONAS, StatoilHydro and Total. Oil and gas ventures are subjected to 'buy-back' arrangements whereby ownership is retained by the Iranian state. NIOC has made several large discoveries, notably the Azadegan field which is yet to be developed and has recoverable reserves of 9 billion barrels (bbls). Other noteworthy fields include Ferdowsi (30.6 billion bbls), Moud (6.63 billion bbls), Zagheh (1.3 billion bbls), Bangestan (600 MMbbls) and Kushk. Iran relies heavily on oil export revenues for approximately 80% of total export earnings and 40% of the government budget[9].

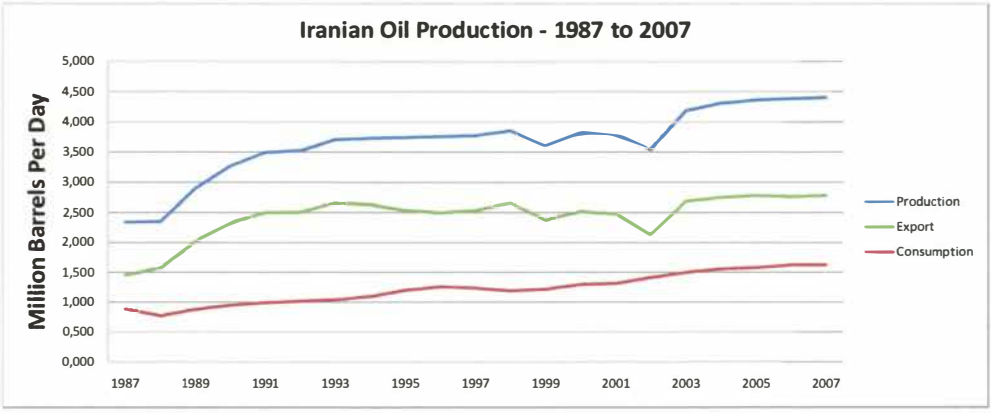

Table 2 - Iranian Oil Production (1987 to 2007)

Venezuela

Venezuela produced 2.63 MMbbl/d in 2007 and consumed 596,000[10] MMbbl/d, therefore it exported 2.03 MMbbl/d[11].

Petróleos de Venezuela S.A. or PdVSA is the state-owned oil company of the Bolivarian Republic of Venezuela and it is responsible for the majority of oil production. Although IOCs such as ConocoPhillips, Chevron and Petrobras are present, they must work with PdVSA.

The country is split into two oil provinces: Maracaibo in the West and the 'Oriente' (Spanish for East), both of which share the same prolific source rock. Oil accumulations are found in Cretaceous limestones and in overlying tertiary sandstones. The East Venezuela Basin is asymmetrical with a long, gently-dipping, southern flank. Oil has migrated up this flank to shallow depths where it has been weathered and has generated sizeable heavy oil and bitumen deposits at depths of 1640 to 4921 ft (500 to 1500 m) along the Orinoco River[12].

Oil export revenues are important for Venezuela because as much as 45% of government revenues come from oil[13].

Based on company figures, PdVSA aims to raise the country's crude oil production capacity to 5.5 MMbbl/d by 2010[14].

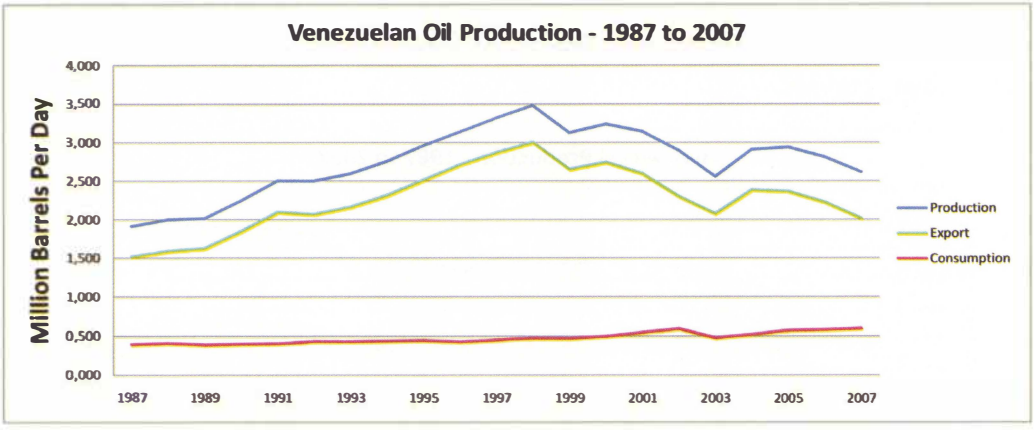

Table 3 - Venezuelan Oil Production (1987 to 2007)

UAE

In 2007, the United Arab Emirates or UAE produced 2.9 MMbbl/d, consumed 0.45 MMbbl/d and exported a total of 2.45 MMbbl/d[15].

The Abu Dhabi National Oil Company (ADNOC) is the major oil and gas producer in the UAE. It is responsible for all operations in Abu Dhabi and owns the Abu Dhabi Company for Onshore Oil Operations (ADCO), which operates in onshore and shelf waters in the Emirates.

ADCO produces oil from five main fields: Asab, Bab, Bu Hasa, Sahil and Shah. The Zakum Development Company (ZADCO) is responsible for oil development and production from the Upper Zakum field. It also operates Umm Al Dalkh and Satah on behalf of its partners. There is also the National Drilling Company (NDC) for onshore and offshore drilling. As with other OPEC countries, relatively strong oil prices and revenues in recent years have helped to significantly improve the UAE's economic, trade, and budgetary situations[16].

The UAE economy is relatively diversified and is in transition from a purely oil-based economy to one that is increasingly moving towards services such as tourism,

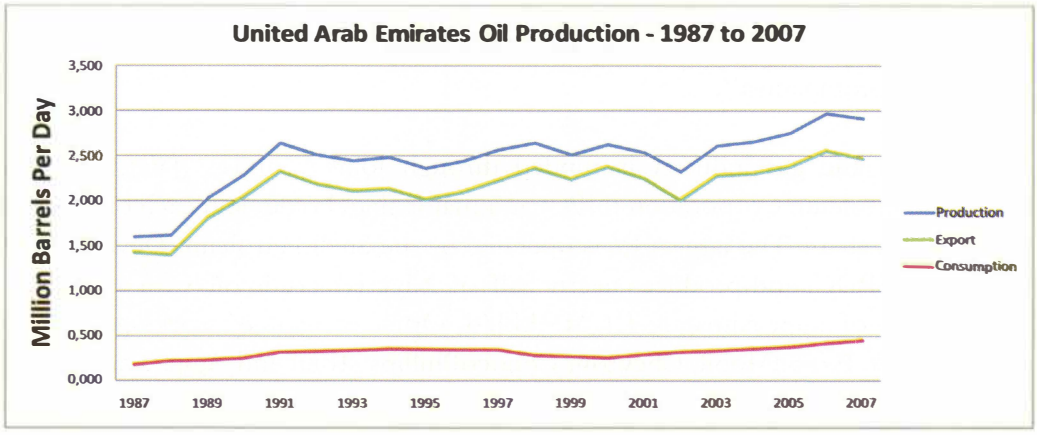

Table 4 - UAE Oil Production (1987 to 2007)

banking, re-exports, information technology, etc. Privatisation has moved ahead relatively quickly, and the country has set up various Free Zones to encourage foreign trade and investment. These moves have helped to moderate the effects of fluctuating oil prices and revenues[17].

Nigeria

Nigeria produced 2.36 MMbbl/d in 2007 and is estimated to have consumed 0.4 MMbbl/d, hence exporting approximately 1.96 MMbbl/d[18].

Most of Nigeria's crude oil production, comprising ten major crude streams (including condensate), is light sweet crude, API grades 21°-45°, with a low sulphur content. Nigeria's marker crudes on the international oil market are Bonny Light and

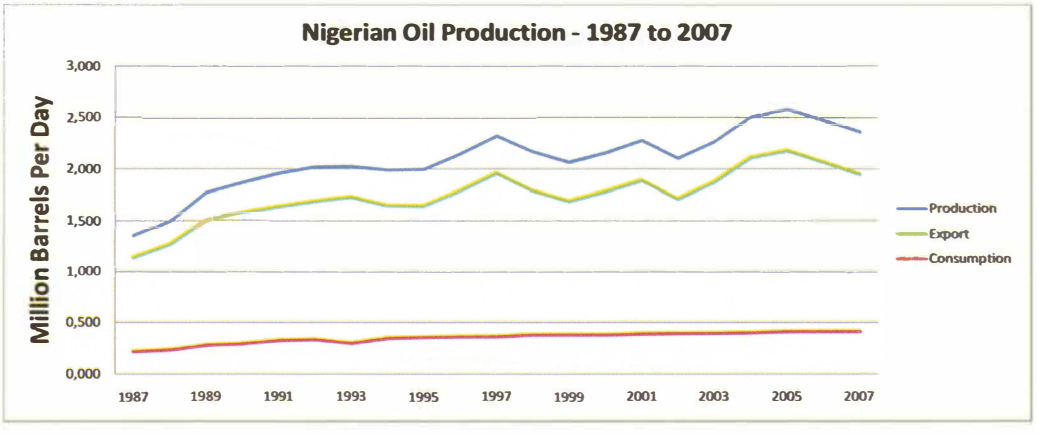

Table 5 - Nigerian Oil Production (1987 to 2007)

Forcados. Numerous fields are known across the Niger Delta, and some of the more marginal fields have become the focus of redistribution with the debate favouring private local companies[19].

Nigeria's oil and gas industry is funded through Joint Ventures (JVs), with the National Petroleum Corporation (NPC) as a major shareholder and each oil company holding a share. The largest JV is operated by the Shell Petroleum Development Company (SPDC) and produces nearly half of Nigeria's crude oil, with an average daily output of approximately 1.1 MMbbl/d. Other companies working with the NPC, include ExxonMobil, Chevron, ConocoPhillips, Total and Agip. The remaining funding arrangements comprise Production Sharing Contracts (PSCs), which are mostly confined to Nigeria's deep offshore development programme.

A number of the oil companies prospecting in the offshore blocks in the Niger Delta, have built up considerable deepwater experience in the Gulf of Mexico (GOM), the Gulf of Guinea (particularly in Angola), and the North Sea. Technology developments have reduced the cost of exploration and production, although profitability is reckoned at levels exceeding 5,000 bbl/d per well.

A number of major discoveries have been recorded with Shell's Bonga and Chevron's Agbami field both estimated to hold one billion barrels each. These successes have turned the focus of Nigerian exploration into deep waters which remains a highly prospective area[20].

Kuwait

Kuwait produced 2.62 MMbbl/d in 2007 and consumed 0.28 MMbbl/d allowing it to export 2.34 MMbbl/d.

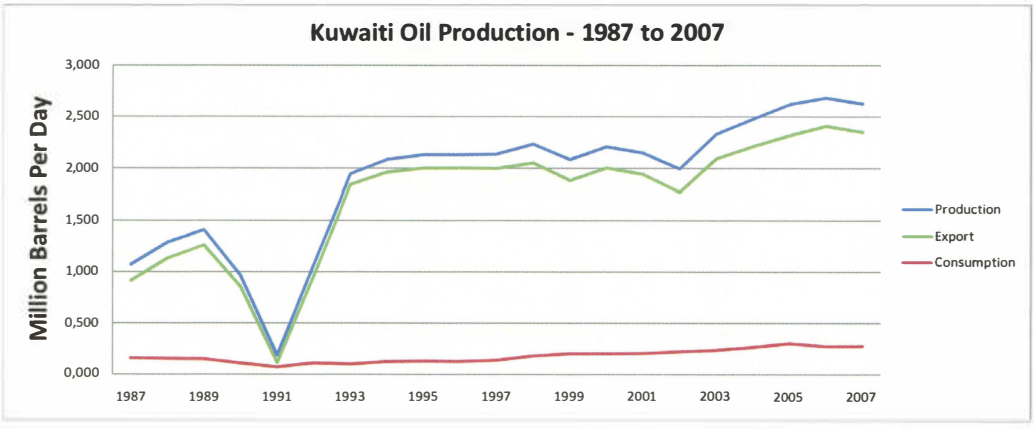

Table 6 - Kuwaiti Oil Production (1987 to 2007)

The Kuwait Petroleum Corporation (KPC) was founded in 1980 with the Government of Kuwait as its sole owner. It owns most of the oil and gas concerns in Kuwait such as the Shuaiba, Al Ahmadi and Mina Abdulla refineries. It is a shareholder, along with BP, of the Kuwait Oil Company (KOC) which produces approximately 2 MMbbl/d. KOC aims to increase production by developing more of the country's light oil and gas reserves in the Jurassic and Paleozoic formations respectively[21].

Iraq

Iraq's oil production has dropped severely since 2000 from 2.61 MMbbl/d to a low in 2003 of 1.34 MMbbl/d. Iraq's oil production, however, has regained capacity and it is worth noting that Iraqi E & P costs are amongst the lowest in the world and, given the application of commonly available technology, the country has the potential to produce at far higher levels.

During 2007, Iraq produced 2.145 MMbbl/d and is estimated to have consumed 0.38 MMbbl/d. It is therefore estimated that Iraq exported 1.76 MMbbl/d[22]. Iraq has 115 billion barrels of proven oil reserves, placing it third worldwide after Saudi Arabia and Iran. Oil production in Iraq is concentrated in two oilfields: Rumaila which has 663 producing wells and Kirkuk which has 337 producing wells.

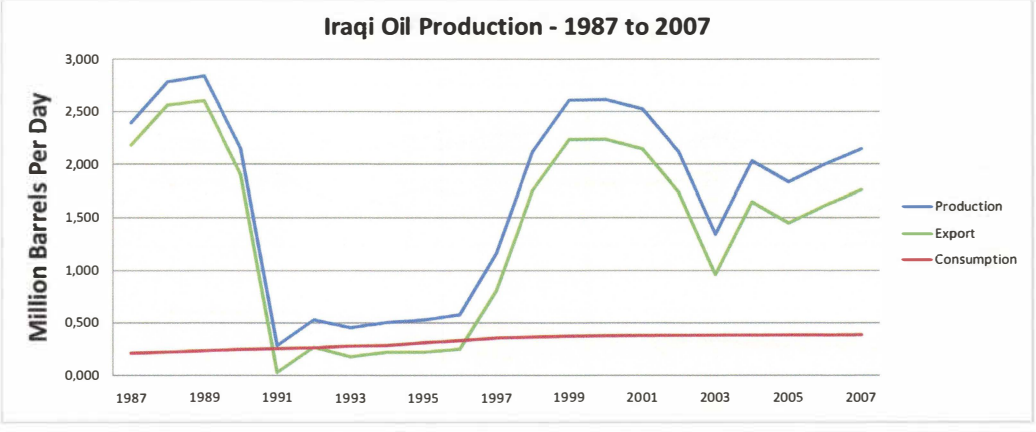

Table 7 - Iraqi Oil Production (1987 to 2007)

Libya

In 2007, Libya produced 1.85 MMbbl/d and was estimated to have consumed 0.30 MMbbl/d, thereby exporting 1.5 MMbbl/d[23].

Exploration onshore is concentrated in the Sirte, Murzuq and Ghadames Basins as well in the areas of Kufra and Cyrenaica.

Among Libya's largest onshore fields are the Amal field and the Gialo field, both with reserves of over four billion barrels of oil. Other large fields occur in the Sarir complex in southern Cyrenaica which is in the southeastern margin of the Upper Cretaceous-Tertiary Sirte Basin, which is one of the most highly productive oil basins in North Africa[24].

The majority of Libya's oil and gas is found onshore in three geological trends of the Sirte Basin. In the West, the known fields are Samah, Beida, Raguba, Dahra-Hofra and Bahi. In the north-centre of the country, there are the giant oilfields of Defa-Waha and Nasser and also the large Hateiba gas field and an easterly trend containing Sarir, Messla, Gialo, Bu Attifel, Intisar, Nafoora-Augila and Amal[25].

In early 2005, Libya held its first round of licences with Occidental, Woodside Petroleum, the UAE's Liwa and Petrobras gaining licences. The country continues to attract foreign investment and now has a relatively diverse E & P sector.

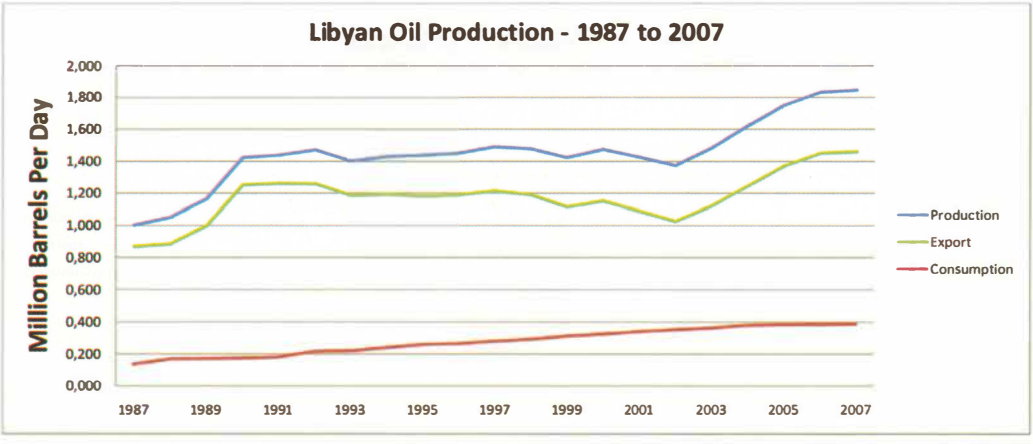

Table 8 - Libyan Oil Production (1987 to 2007)

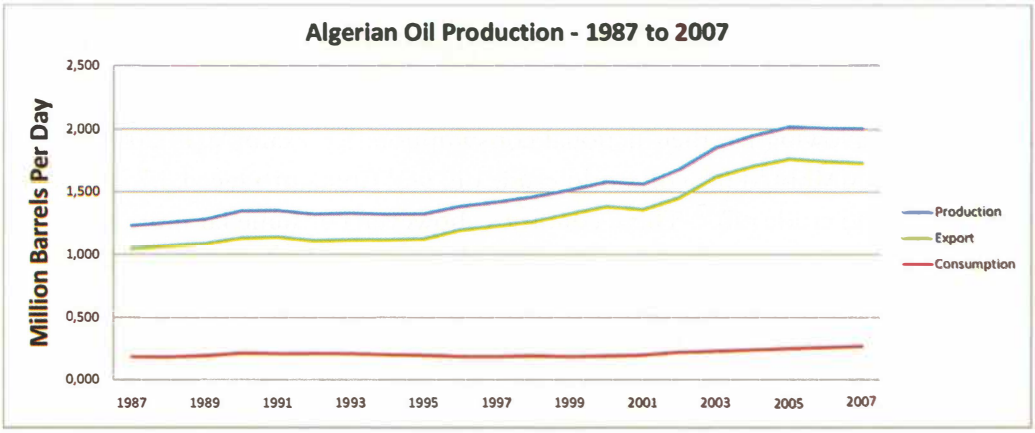

Table 9 - Algerian Oil Production (1987 to 2007)

Algeria

In 2007, Algeria produced 2.0 MMbbl/d, consumed 0.27 MMbbl/d, and exported 1.73 MMbbl/d. Additionally, Algeria is an established Liquefied Natural Gas (LNG) exporter serving European and US markets.

The petroleum sector is dominated by the NOC Sonatrach which is owned by the Algerian government. Through its subsidiaries, the company has a domestic monopoly on oil production, refining, and transportation. Upstream activities, however, are open to foreign companies, who must work in partnership with Sonatrach, with the company in question usually holding majority ownership in production-sharing agreements. The most notable of these companies are Anadarko, BHP, BP and Repsol[26]. Algeria's Saharan Blend oil is a preferred sweet and light crude approximately 46° API. As of 2007, Algeria had 160 trillion cubic feet (Tcf) of proven natural gas reserves. Hassi Messaoud is the country's largest oilfield and is owned by Sonatrach with average production of 0.350 MMbbl/d of sweet and light 46° API crude. The Hassi Messaoud complex is reckoned to hold six billion barrels and is expected to provide approximately 0.7 MMbbl/d over the next five years. Sonatrach also operates the Hassi R'Mel field, which produced 0.18 MMbbl/d of 46.1° API crude. Anadarko produces approximately 0.5 MMbbl/d from the Hassi Berkine and Ourhound fields in eastern Algeria and is also developing further assets.

Major non-OPEC Producers

Major non-OPEC producer countries are the US, Russia, Mexico, China, Canada and Norway. The focus here, however, should be on producers that make significant oil exports after allowing for their national consumption: for example, in 2007 the US produced 6.9 MMbbl/d (8% of world crude oil) and China produced 3.7 MMbbl/d (4.8%. of world crude oil)[27]. These countries , however, consume far more than they produce. In 2007, oil consumption for the US was 20.7 MMbbl/d and for China 7.89 MMbbl/d, making these two countries the world's largest net oil importers. In the case of Canada, the oil produced was 3.30 MMbbl/d and consumption was 2.30 MMbbl/d, making net exports 1.0 MMbbl/d in 2007[28].

Consequently, after stripping out domestic consumption, significant non-OPEC* net oil exports lie in the hands of four countries: Russia, 7.28 MMbbl/d; Norway, 2.34 MMbbl/d; Mexico, 1.45 MMbbl/d; and, Kazakhstan, 1.27 MMbbl/d.

Considering net exports, the importance of OPEC exports becomes strikingly clear as ten of the world's major oil exporters (more than one MMbbl/d) belong to OPEC, a total which is roughly double that of the combined non-OPEC exports[29,30,31].

Non-OPEC and OPEC Major Net Exporters of Oil 2007

Non-OPEC oil production has risen in the past few years, notably from Russia which briefly displaced Saudi Arabia as the world's foremost crude oil producer in 2006 and from rising exports from central Asian states such as Kazakhstan[32]. It is recognised, however, that only Saudi Arabia retains the existing spare capacity required to meet the predicted total world oil demand growth over the next five years. Other areas such as Offshore West Africa (Angola) and Offshore East Brazil are increasing production, with Brazil reaching a narrow margin of self-sufficiency in April 2006. Neither, however, is likely to make a major impact on world oil exports over the next decade especially considering the high costs associated with these deepwater developments[33].

A Wider OPEC?

It is often reported that the ripples of OPEC decisions are always most keenly felt by consumers 'at-the-pump' in importing countries; however, OPEC decisions can equally affect oil exporting countries. OPEC decisions can influence oil price trends (other things remaining equal), which can affect the revenues realised by oil exporters. This has been noted by certain non-OPEC countries which may see certain

* More than one million barrels per day per country.

advantages of some degree of co-ordinated production policies with OPEC. Russia and Norway are two examples, although they have not always actually carried out co-ordination.

While the stated volumes of non-OPEC production (or export) restrictions have usually been small, the participation of these non-member countries can lead to accentuated effects as market analysts attribute value to such actions and can lead to even greater cohesion with OPEC in restricting output. In this way, the effect of wider co-ordination with OPEC policies is not often recognised[34]. High or increasing oil prices since 2000, however, have led non-OPEC to maximise production rather than restrict output. Whether intended or not, since 2000 there have been similar actions from OPEC and non-OPEC exporters. Since 2003, Mexico, Norway, Russia, Oman and Angola have all pushed to maintain or increase production in the high price environment. The peak prices of mid 2008 of US $147 and the subsequent collapse of oil prices to US $35 by the end of 2008 prompted dramatic production cuts from OPEC. Russia participated as an 'observer' in OPEC meetings, but made no production cuts.

World Oil Consumption

Of the 85.22 MMbbl/d of oil consumed worldwide in 2007, OPEC countries together consumed approximately 7.6 MMbbl/d, which again shows their importance in sustaining production. Of the world's top ten oil consumers in 2007, only Russia has significant net oil exports. The remaining top consumers are listed as the world's largest oil importers, with the exception of Brazil, which reached oil self-sufficiency in April 2006[35].

Estimates of proven oil reserves vary, but the essential fact remains that most of the world's proven oil reserves are held by OPEC. According to OPEC statistics, world proven reserves are 1.15 trillion barrels of proven reserves, of which OPEC holds 0.9 trillion barrels[36]. According to BP's statistical review, world proved reserves are 1.2 trillion barrels, of which 0.9 trillion are held by OPEC[37] and 0.30 trillion are held by non-OPEC members. According to the US Energy Information Association (EIA) which bases it figures on the Oil and Gas Journal, total reserves are 1.3 trillion of which 0.85 trillion are held by OPEC[38]. The remaining reserves are split between Russian, the Former Soviet Union (FSU) and Canada.

Non-OPEC reserves include Canadian unconventional reserves which have higher production costs[39]. In the future, the inclusion of unconventional oil reserves for

other countries may positively affect OPEC member Venezuela, as well as non-OPEC countries such as Canada, Brazil and Australia. The reserves of non-OPEC countries are being depleted more rapidly than OPEC reserves. Non-OPEC reserves-to-production ratio—an indicator of how long proven reserves will last at current production rates—is approximately 26 years for non-OPEC. OPEC reserves-to-production is 73 years based on 2007 crude oil production rates. Combining the longer reserves life and the high net oil exports figures, it is clear to see just how important OPEC production is over the long term[40].

Refinery Capacity

Countries that have high petroleum demand tend to have large refinery capacities due to proximity to end consumers. Exemplifying this, the US is the world's largest consumer and has the highest refinery capacity in the world, with 20% of the world's crude oil refinery capacity (17.59 MMbbl/d of a total 87.91 MMbbl/d).

Russia's refinery capacity stands at an estimated 5.58 MMbbl/d. Japan (4.56 MMbbl/d) and China (7.5 MMbbl/d) are the only remaining countries with refinery capacities exceeding 3 MMbbl/d[41]. There are several countries that are important to world trade in refined petroleum products despite very low (or non-existent) levels of crude oil production. For instance, Caribbean nations (including US and European territories) have very limited oil production (233,000 bbl/d in 2007), but a refinery capacity of about 2.6 MMbbl/d. Much of this refined product is exported to the US[42].

Review of Major Non-OPEC Oil Exporters

Russia

Russia produced 9.98 MMbbl/d in 2007 and consumed 2.7 MMbbl/d in the same period. The country therefore exported 7.28 MMbbl/d during 2007 making it the second largest oil exporter after Saudi Arabia.

After the break-up of the Soviet Union in the early 1990s, the nature of the Russian oil industry changed dramatically. From being geographically dispersed and technically fragmented with numerous state-owned entities, the State set about vertically integrating these companies in the likeness of IOCs. Behind the scenes inter-related forces were at work. Central Asian states such as Kazakhstan became sovereign nations and were developing their respective oil and gas industries rapidly and independently. These Central Asian Republics had succeeded in attracting and retaining

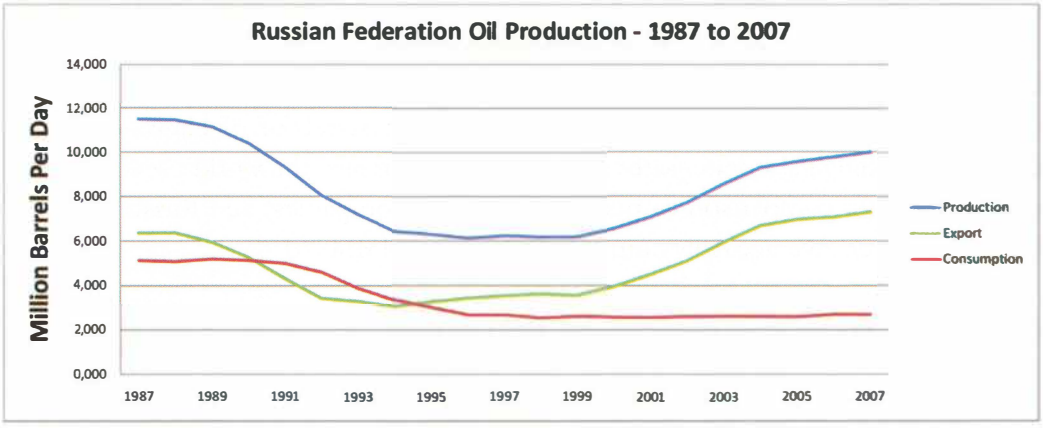

Table 10 - Russian Federation Oil Production (1987 to 2007)

oil and gas investment capital. The Russian government acted to restructure its own industry, not only to attract investment, but also to integrate its NOCs so that they could compete both at home and overseas. It also acted to counter market volatility by channelling windfall oil revenues into a stabilisation fund that came into effect in 2004[42].

Today, several Russian oil companies compete globally and the stabilisation fund is believed to be worth almost US $60 billion—approximately 7.5 percent of the country's Gross Domestic Product (GDP). Taxes on oil exports have been raised significantly and private oil companies complain that the higher export taxes are hindering efficient allocation of profits into exploration and development[43].

The decision to develop Shtokman without foreign partners is a signal as strong as any of Russia's move toward nationalisation and emergence as an independent energy power. IOCs such as Chevron, ConocoPhilips, Total and Norwegian company StatoilHydro were excluded from the development and this came as a surprise as it was commonly thought that partnership with a foreign company would occur, especially one with technical expertise, in the harsh conditions of the Barents Sea[44].

Major Russian oil companies that have majority state holdings are Rosneft, Gazprom, Transneft and Rosgas. Other privately-owned companies such as Lukoil are locally owned, while TNK is a BP owned venture and Sakhalin Energy is a consortium of major oil companies.

Rosneft

Rosneft's E & P efforts have been growing steadily and were strengthened by the US $9.3 billion acquisition of Yuganskneftegaz (ex-Yukos), which established the company's proved oil and gas reserves at 21.69 billion barrels of oil equivalent (boe) in 2007 (including gas condensates and gas). Rosneft is also the world's seventh largest producer (in comparison to publicly traded oil companies) and Russia's second largest producer. Average daily output in 2007 was 2 MMbbl/d[45].

Central to Rosneft's cash flow and portfolio is Yuganskneftegaz, which represents approximately two thirds of the company's annual oil production and over 70% of its proved SPE oil reserves. Purneftegaz is Rosneft's second largest production asset. With large non-associated natural gas reserves at the Kharampur field, it is likely to increase in importance as Rosneft seeks to further monetise its gas reserves. Additional exploration in the Timano-Pechora oil province and expanded export capacity at the Arkhangelsk terminal have helped Rosneft grow[46].

Rosneft holds more than a third of Sakhalin's total offshore oil and gas resources. It holds sizeable stakes in all five stages of development. While still at the early stages of exploration, it holds stakes in the Sakhalin-3, Sakhalin-4 and Sakhalin-5 of 49.8%, 51% and 51%, respectively. Rosneft holds a stake in the Sakhalin-1 project, which is currently being developed under a Production Sharing Agreement (PSA) implemented in 1996 with ExxonMobil and Sodeco of Japan (and, since 2001, with India's ONGC). Sakhalin-1 began oil and gas production in late 2005 and is anticipated to experience substantial growth over the next several years[47].

Rosneft also holds interests in Eastern Siberia, in the form of the Vankor field in Krasnoyarsk and with TNK-BP, the Verkhnechonsk field in the Irkutsk.

Other resources on the Black Sea shelf, Sea of Azov and the Kurmangazy structure in Kazakhstan could help the company's future plans for growth[48].

Gazprom

In 2007, GazpromNeft's oil production was 660,000 bbl/d. It comprises nearly half a million shareholders with the Russian Federation controlling a majority of 50.002%. According to the company, it employs some 300,000 people in different operations[49]. Gazprom and its producing subsidiaries hold more than 40 oilfield exploration and development licences in the West Siberian petroleum basin, as well as in Omsk and

Tomsk in Chukotka. It acquired Sibneft which has 80% of its reserves concentrated in Noyabr'sk with four large fields—Sugmutskoye, Sutorminskoye, Vyngapurovskoye and Sporyshevskoye—accounting for nearly 50% of Sibneft's reserves. Sibneft was also active in upstream oilfield services and is active in the geophysical arena through OJSC Noyabr'skneftegazgeophysica—a geophysical services company that offers borehole logging, perforation and seismic data preparation[50]. During recent years, Sibneft has spun-off several service companies that were formerly production divisions including Service Drilling Company LLC and Well Workover Service Company LLC. These service companies compete with other Russian and international drilling and service contractors, providing drilling and well work over services[51].

Gazprom—Natural Gas

Russia has the largest natural gas reserves in the world, 1.58 trillion cubic feet (Tcf). In 2007, Russia was the world's largest natural gas producer (58.8 billion cubic feet [Bcf]), as well as the world's largest exporter (16.3 Bcf)[52].

Russia's natural gas infrastructure, however, needs updating and its natural gas industry has not experienced the success of its oil industry, with limited growth in gas production and consumption[53].

Three major fields in Western Siberia—Urengoy, Yamburg, and Medvezh'ye—comprise more than 70% of Gazprom's total natural gas production, but these fields are now in decline. Although the company projects increases in its natural gas output between 2008 and 2030, most of Russia's natural gas production growth will come from independent gas companies such as Novatek, Itera and Northgaz. Barents Sea Exploration of the Russian Barents Sea began in the 1970s and to date discoveries in the area consist of ten significant gas and condensate fields, as well as a total of 125 identified fields or potential structures. Total reserves are estimated between five and ten trillion cubic metres[54].

The largest deposit is the Shtokman (Shtockmanovskoye) gas and condensate field, discovered in 1988, with total reserves of 3 trillion m^3, and with estimated recoverable reserves (C_1+C_2) of 2.5 trillion m^3. Gazprom plans to develop the Shtokman field on its own and expects it to become the resource base for the export of gas to Europe through the Nord Stream pipeline (which is currently under construction)[55]. The energy resources of north-west Russia remain largely unexploited. The total hydrocarbon resources of the Russian Arctic shelf are estimated at about 100 billion

tonnes of oil equivalent (toe). The natural gas reserves in north-west Russia form the most important strategic energy resource in the region. Estimates placed on Barents Sea reserves vary from 2 trillion m^3 to 5 trillion m^3. In any event, these reserves offer a major supply contribution to European energy needs. In addition, it is expected that there are also oil deposits in the eastern and northern areas of the Barents Sea. Furthermore, the so-called 'grey zone', formed by the sea boundary claims of Norway and Russia, is considered a promising gas or oil province.

The Timan-Pechora oil and gas region has estimated total oil resources of over 4,800 million tonnes, of which over 1,400 million tonnes is estimated to be recoverable. The Republic of Komi has 520 million tonnes of oil resources. Perhaps the most significant deposit found in the Pechora Sea is the Prirazlomnoye oil field, with estimated reserves of 56-62 million tonnes. The licence for the development of the field is held by JSC Rosshelf, and the Australian company BHP is participating in the development of this field. The exploration of Barents Sea oil resources is still at an early stage[56].

The Timan-Pechora province is considered the third most important oil producer of the Russian Federation, and there is a significant development potential in the area. If the above-mentioned oil reserves are compared world-wide, they are equivalent to Norway's North Sea reserves; however, most of the approximately 200 fields in the region are quite small. Gas reserves are rather small compared to the Barents Sea reserves, for example, which means that they are mainly of local importance[57].

Transneft Russia needs to expand export capacity for its oil and gas in order to monetise growing production. Crude oil exports via pipelines, however, are under the jurisdiction of Russia's state-owned Transneft. The Transneft system cannot meet export needs with an excess of approximately three million barrels of its total seven million barrels transported by road, rail and river routes[58]. This means substantial investments must be made to ensure growing levels of production can reach the markets, especially foreign ones.

Several proposed oil pipeline routes and pipeline expansion projects are planned including the Baltic Pipeline System (BPS), which carries crude oil from Russia's West Siberian and Timan-Pechora oil provinces westward to the newly completed port of Primorsk in the Russian Gulf of Finland[59].

Sakhalin Island

Several IOCs entered into PSAs to develop the resources in Sakhalin Island, Okhotsk Sea (see *Chapter 8: Extreme E & P*). Oil reserves in the area are estimated at around 14 billion barrels, and natural gas reserves at approximately 2.6 trillion cubic metres[60].

The Sakhalin-1 project was led by Exxon Neftegaz, in conjunction with consortium members SODECO, ONGC Videsh, Sakhalinmorneftegaz and RN Astra. The Sakhalin-2 project was developed by Shell, Mitsubishi and Mitsui, and entails the development of Russia's first LNG facility to be built on the southern tip of the island. Sakhalin-2 will also be used to supply natural gas to the United States, Korea and Japan in 2008. Sakhalin 3-6, North and South East of Sakhalin Island, are at the planning stages of development[61].

Norway

Norway had 8.2 billion barrels of proven oil reserves at the end of 2007, the largest in Western Europe. Norway's oil reserves are located offshore on the Norwegian Continental Shelf (NCS), which is divided into the North Sea, the Norwegian Sea and the Barents Sea[62].

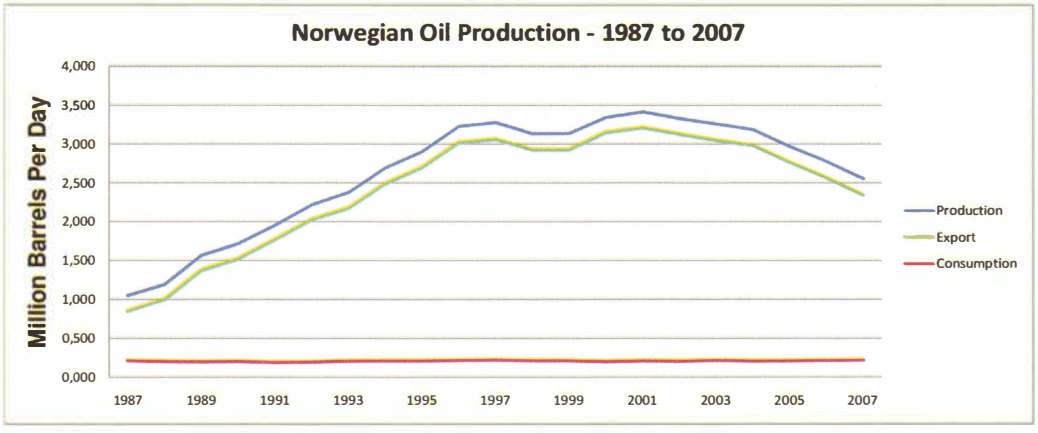

Table 11 - Norwegian Oil Production (1987 to 2007)

Oil and Gas Exports

Norway produced 2.56 MMbbl/d in 2007 and consumed 221,000 bbl/d in the same period. The country therefore exported 2.34 MMbbl/d during 2007. Norway has significantly increased its natural gas production; in 2007 it produced 8.7 bcf and consumed 0.4 bcf[63].

The United Kingdom is the largest importer of Norway's oil and gas having imported 814,500 bbl/d from Norway, or 34 % of Norway's 2007 total exports.

In contrast to its maritime neighbour, the UK, Norway's government holds a dominant stake in the oil sector and controls 66.42% of StatoilHydro (the remainder of the shares are owned by international, institutional and private stockholders)[64].

StatoilHydro itself holds more than 80% of Norway's oil and gas production. Additionally, Norway's government owns approximately 40% of the country's total oil production through the State Direct Financial Interest (SDFI). State-owned Petoro administers these ownership interests, while StatoilHydro is responsible for managing actual production from SDFI assets[65].

IOCs do have a sizeable presence in the NCS, but they must act in partnership with StatoilHydro. The largest private oil producers in Norway are ConocoPhillips, ExxonMobil and BP. Petoro is the state limited company which is responsible for managing, on behalf of the government, SDFI[66].

While the state has the ownership of the SDFI's assets, Petoro acts as the licencee in production licences, pipelines and land-based plants on behalf of the government. The primary objective of Petoro's administration of the SDFI portfolio is to achieve the highest possible income for the state. The SDFI arrangement involves the state paying a share of all investments and operating costs in projects which correspond to its direct financial interest. On the same terms as the other owners, the government then receives a matching share of revenues from the sale of production and other income sources.

The licencees, and in particular the operator, are responsible for developing discoveries which are made within the boundaries of a licence. Should there be a need for research and technology development to overcome technological challenges in developing the discovery, the tax system provides favourable conditions to ease the burden of such efforts. Relevant expenditures on research are fully deductible against tax and there is a special tax scheme aimed at stimulating research and development in industry ('Skattefunn'). Due to the nature of oil exploration and production in the NCS, the region has traditionally been accessible only by international oil majors. Because of harsh weather and operating conditions, projects in the NCS require sizable initial investments. Further, the structure of Norway's petroleum taxes means that smaller, marginal fields often are not profitable. Finally, stringent environmental, safety, and labour regulations further increase operating costs[67].

Technology Development

The Ministry in Norway funds petroleum-related research programmes which are administered by the Norwegian Research Council. The two most important programmes are called Petromaks and Demo 2000. Petromaks deals with basic and applied research and Demo 2000 covers the demonstration/application of new technology. The main aim of both programmes is to increase value creation on the Norwegian Continental Shelf and to increase the export of Norwegian oil and gas technology. The Ministry has also established OG 21, 'Oil and Gas in the 21st Century', which provides overall guidance on priorities for the public research and technology programmes, as well as for related activities in universities, research institutes and industry through a comprehensive national R & D strategy. The OG 21 board consists of members from oil companies, the supply industry, research institutions and academia. The implementation of the OG 21 strategy is largely based on the activities of the Petromaks and Demo 2000 programmes and on joint industry projects[68].

As with any development project on the Norwegian Continental Shelf, the Ormen Lange and Snøhvit developments have been driven by commercial interests. The Ministry's role in development projects is to coordinate the administrative procedures and approval processes, ensuring that the projects comply with sound resource management practice, as well as balancing all interests with regard to value creation, environmental concerns and the fisheries. With regard to Snøhvit, minor tax regime adjustments were made to facilitate the development of the LNG projects[69].

Production

The bulk of Norway's oil production occurs in the North Sea, with smaller amounts in the Norwegian Sea. In 2007, LNG production of the Snøhvit field was scheduled to commence which brought development to Hammerfest. Most of the Barents Sea is unexplored and activity there will always be subject to high costs associated with a harsh offshore area and environmental concerns as the seas have abundant fish stocks and are considered unpolluted. The Barents Sea is likely to contain oil and gas reserves, but the question remains one of delineation. To this end, the Norwegian government has restarted licensing in the Barents Sea and companies such as StatoilHydro are looking keenly to what some consider as a new frontier for the Norwegian Petroleum Industry[70].

Exploration and Production

Norwegian oil production rose dramatically from 1980 until the mid-1990s, remained flat since (see Table 11) and has now started to decline. During the first six months of 2005, for example, Norway's oil production averaged 2.95 MMbbl/d, while in 2007 the average figure was 2.55 MMbbl/d. As North Sea fields continue to mature, Norwegian oil production will focus on mature fields, though it is expected that new developments in the Barents Sea will offset some of this decline.

One of the largest oil fields in Norway is the Troll complex operated by StatoilHydro. Other important fields include Ekofisk (ConocoPhillips), Snorre (StatoilHydro), Oseberg (StatoilHydro), and Draugen (Shell). ConocoPhillips, ExxonMobil and BP operate oilfields in Norway. There is a great emphasis on increasing production from existing projects, including the incorporation of smaller satellite fields that will take advantage of the existing infrastructure[71].

As was the case with the United Kingdom, however, many oil majors have begun to withdraw from the NCS in order to pursue projects in high-growth regions. StatoilHydro have begun to sell NCS interests in order to pursue projects in Latin America and Africa.

Mexico

Pemex (Petróleos Mexicanos) was created as a result of the 1938 Mexican President Cardenas' nationalisation of the oil industry.

Today, the company is responsible for all petroleum production in Mexico which is 3.48 MMbbl/d (2.02 MMbbl/d consumption) and 4.5 bcf of gas production (5.2 bcf consumption). The United States is the destination of over 70% of Mexico's 1.46 MMbbl/d exports[72].

A highly prospective area for Mexico are the Mexican waters of the 'Gulf of Mexico' or GOM which to date have only been developed within the US territorial jurisdiction. Mexico's reservoirs are mostly high permeability limestone reservoirs, while the US tends to be lower permeability sandstones. This in part accounts for the higher average Pemex production well rates of approximately 6000 bbl/d per well. The onshore Burgos Basin on the Mexico-U.S. border shares similar gas prone characteristics with its onshore South Texas neighbours[73].

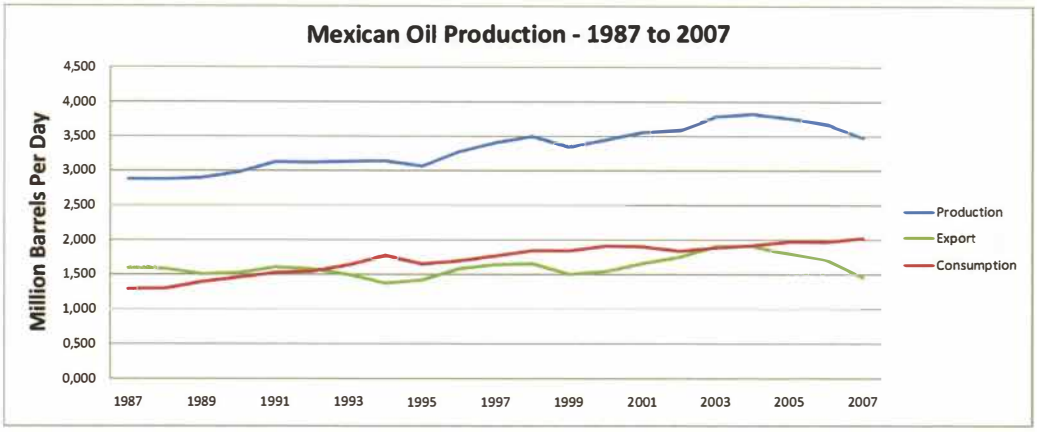

Table 12 - Mexican Oil Production (1987 to 2007)

Mexico must prove its deeper GOM trends and in recent times has issued new discoveries such as Noxal. It has been said that it could be a difficult and longwinded task for Mexico to develop its own deepwater expertise, but this argument fails to recognise that many service provisions could be made by service and supply companies rather than oil companies. However, by bringing in reputed deepwater oil companies, the best development strategies could be applied to the GOM Mexican deepwaters.

Kazakhstan

The Caspian Sea contains six separate hydrocarbon basins and has attracted much foreign investment as most of its oil and natural gas reserves are undeveloped and unexplored with the notable exception of Kashagan, which is the flagship project in the North Caspian Sea. High prospectivity is the cause of interest in the Caspian Sea region, but for net oil exports Kazakhstan alone is relevant (although Azerbaijan and Turkmenistan are worth noting for future production growth)[74].

Kazakhstan produced 1.49 MMbbl/d in 2007 and consumed 219,000 bbl/d in the same period. The country therefore exported 1.27 MMbbl/d during 2007.

Proven Kazakhstani oil reserves are 39.8 billion barrels (defined as oil and natural gas deposits that are considered 90% probable) and gas reserves are 67.2 Tcf. The figure for the Caspian sea is much higher but is split between several states. Kazakhstan's reserves are very much a work-in-progress as the country is relatively unexplored and untapped. Even relatively high-profile Kashagan does not have any final proven oil reserves figures as it is still undergoing appraisal and exploratory

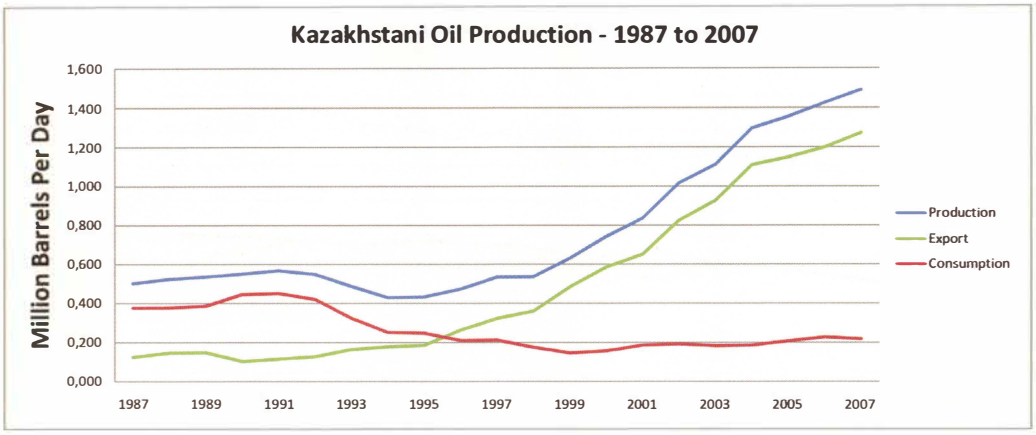

Table 13 - Kazakhstani Oil Production (1987 to 2007)

well drilling. After Russia, Kazakhstan was the largest oil-producing republic in the Soviet Union and has successfully attracted foreign investment in its oil sector to increase oil production to 1.49 MMbbl/d in 2007, most of which came from two large onshore fields (Tengiz, and Karachaganak) and the offshore complex of Kashagan which is still under appraisal and first oil is not expected before 2011. The Tengiz oil field is estimated to contain recoverable oil reserves of six to nine billion barrels. The Kashagan complex has an unitisation agreement that covers the Kalamkas, Aktoty and Kairan blocks[75]. North Caspian Operating Company (partners include ExxonMobil, Shell, Total, Eni, ConocoPhillips, Inpex and National Oil Company KazMunaiGas) is developing the Kashagan complex. The field was discovered in June 2000, when the first exploration well (KE-1) was drilled with 13 billion tonnes of oil potentially recoverable with the use of gas re-injection[76].

Now that we have in-depth knowledge of where our oil and gas resources are located, we need to think about how one actually gets access to these resources. Does one need to buy the land from those who own it? Are there procedures and policies in place that need to be followed? What are the legal requirements? Who can actually acquire oil or gas fields? Who are the major players in this area?