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2010 – Issue 16

# Brazil oil & gas

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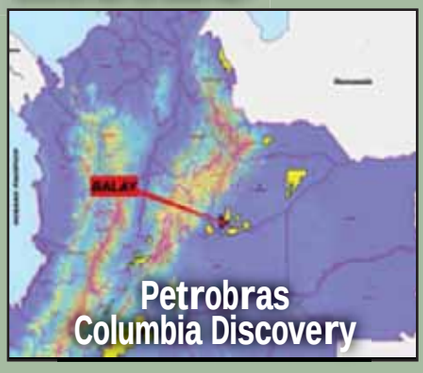
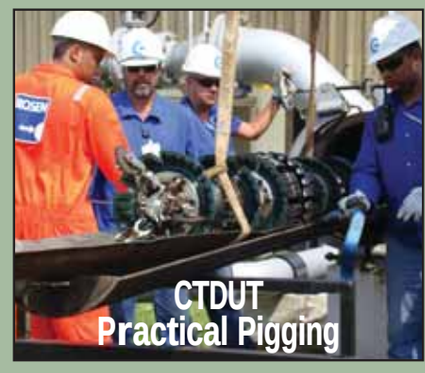
## Inside




Petrobras
Columbia Discovery



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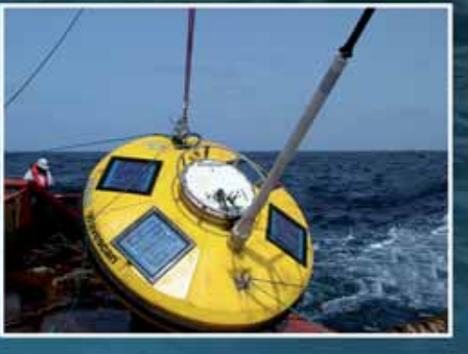


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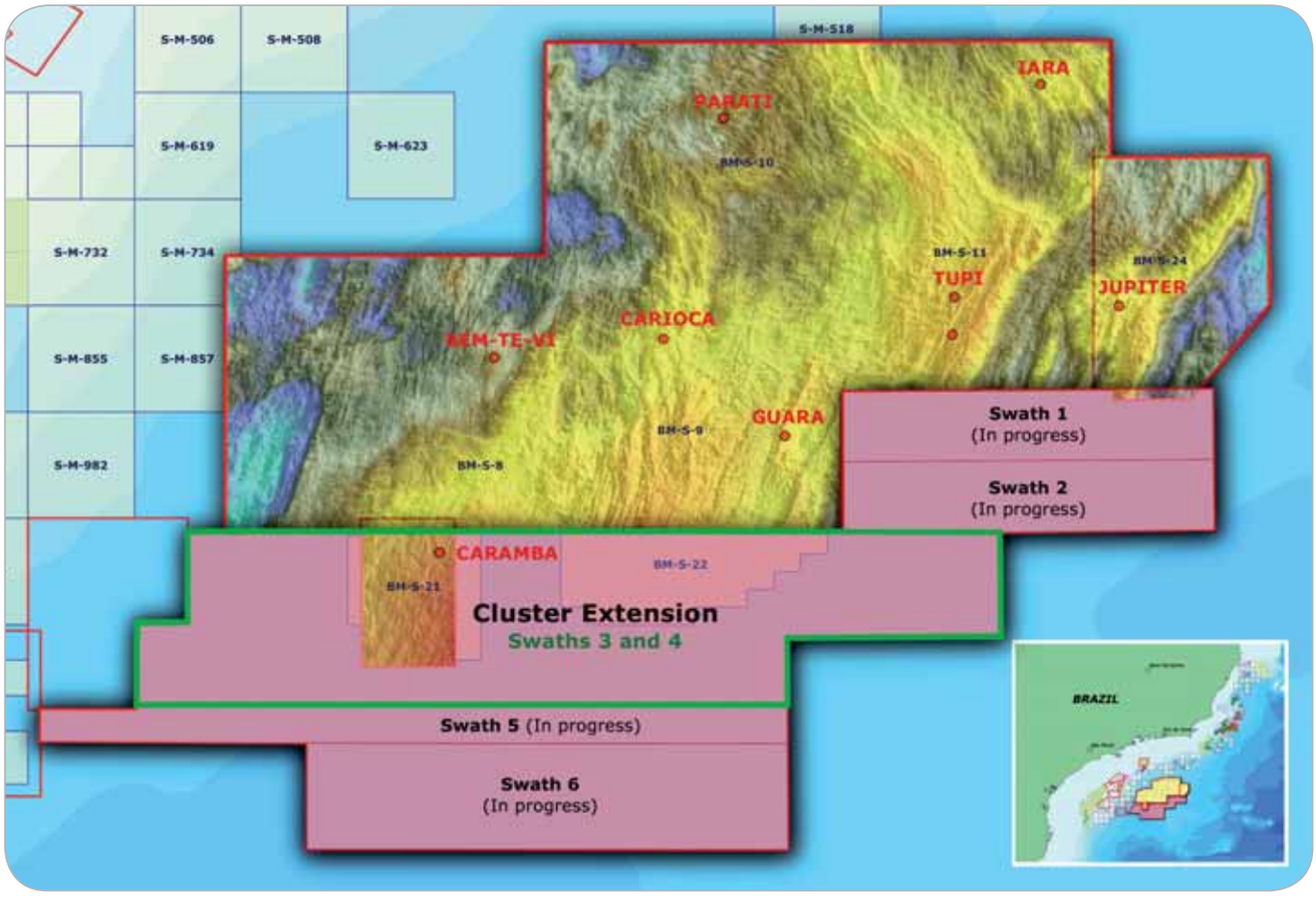


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# Brazil oil & gas

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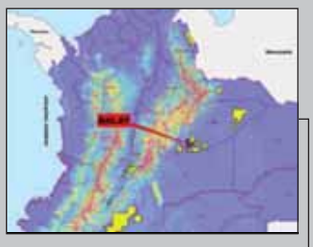

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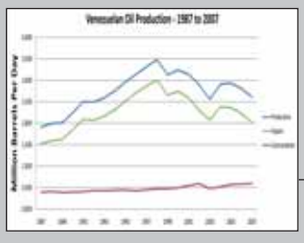


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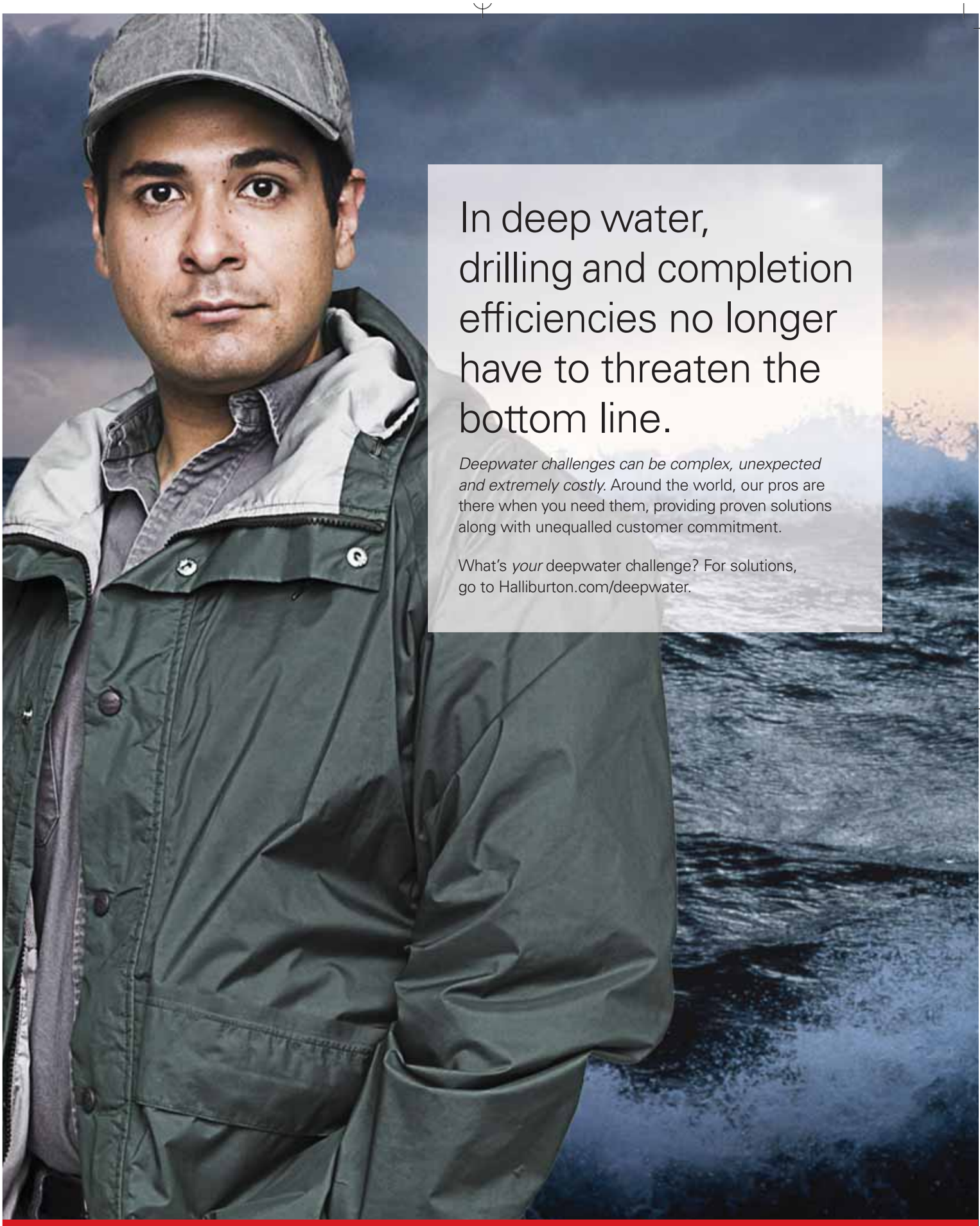


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# Petrobras Sets New Production Records

By Petrobras News Agency

Petrobras set a new monthly oil production record in April. The month's average topped-out at 2,032,620 barrels per day, exceeding the previous monthly record, of 2,003,940 barrels per day, set in September 2009, by 29,000 barrels. This mark was 2.9% higher than a year ago and 1.9% more than March 2010.


In addition to the monthly record, Petrobras also set, on April 23 and 24, two consecutive daily oil and LNG production records, reaching 2,081,570 and 2,082,543 barrels, respectively.

These results were the outcome, among other factors, of the good operational performance of the platforms located off the coast of Rio de Janeiro and Espírito Santo, with the spotlight on the interconnection of new wells to FPSO Cidade de Vitória, in the Golfinho Field (state of Espírito Santo); on new wells going into production in the Marlim Leste field, in the Campos Basin (state of Rio de Janeiro); and on the Extended Well Test (EWT) being started at Tiro, in the Santos Basin, on March 19.

Onshore production also influenced these results, particularly with two new wells going into production in the fields of Rio Urucu (RUC) and Leste do Urucu (LUC), in Amazonas.

Although over 85% of the oil produced by the company in Brazil comes from offshore fields, Petrobras has achieved good results in its onshore areas. The average production of these fields has hovered around 215,000 barrels of oil per day, a volume that has been maintained over recent years thanks to new technologies the company has developed to enhance the useful life of mature fields.

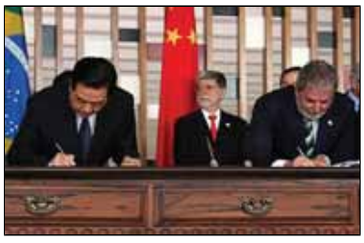
With FPSOs Cidade de Santos coming into operation in upcoming months in Uruguá/Tambaú, and Capixaba, at Cachalote/Baleia Franca, respectively, the company expects to set new production records.

The chart shows the production of each state in April, in barrels per day (bpd).

| STATE TOTAL | |
|---|---|
| Amazonas | 56,264 |
| Ceará | 9,043 |
| Rio. G. do Norte | 57,837 |
| Alagoas | 7,943 |
| Sergipe | 45,889 |
| Bahia | 45,920 |
| Esp. Santo | 145,129 |
| Rio de Janeiro | 1,649,633 |
| Paraná (shale) | 3,664 |
| São Paulo | 11,299 |
| TOTAL IN BRAZIL | 2,032,620 |

# Cooperation Agreement with China

By Petrobras News Agency



Petrobras announces that in April (4/15) it signed a Strategic Cooperation Agreement with China Petrochemical Cooperation (Sinopec) and China Development Bank Corporation (CDB) aimed at assessing mutually beneficial opportunities on the areas of cooperation. The Agreement is a development of the Memorandum of Understanding (MOU) signed between Petrobras and Sinopec on May 19th, 2009.

The Agreement includes the cooperation between Petrobras and Sinopec in the following areas: Exploration & Production (E&P); Downstream; Petrochemical and Fertilizers; and Services and Procurement.

In the E&P area there stands out the intention of the parties to assess future partnerships, including the possibility of selling part of Petrobras's interest in blocks BM-PAMA-3 and BM-PAMA-8, located in the Pará-Maranhão Basin.

In Downstream and Petrochemical, the parties intend to assess opportunities for partnership in the Petrochemical Complex of Rio de Janeiro – Comperj, besides the possibility of new oil supply contracts to Sinopec.

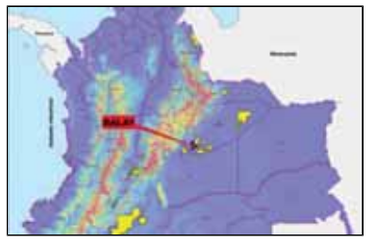
In addition, the Agreement includes the cooperation with CDB in relation to the possibility of bilateral financing under the scope of the Cooperation Agreement, to be negotiated between the parties by Petrobras demand.

The Agreement includes the cooperation between Petrobras and Sinopec in the following areas: Exploration & Production (E&P); Downstream; Petrochemical and Fertilizers; and Services and Procurement.

# Petrobras Announces a Discovery in an Onshore Block in Columbia

By Petrobras News Agency

Petrobras announces an oil discovery in the Balay onshore exploration block, in Colombia, of which its subsidiary Petrobras Colombia Limited is the operator, holding 45% of its equity stakes. The discovery was made by drilling pioneer well Balay-1, in the Llanos Basin, in the Department of Casanare.



The Balay-1 borehole reached a final depth of 4652 meters. The formation test operations proved the existence of oil, of about 28º API and at an initial flow of 1,314 barrels of oil per day. Testing operations are still ongoing aiming to assess the potential of the discovery.

Balay Block consortium operator Petrobras' partners in the business are Cepcolsa, with 30% stakes, and Sergenia E&P Colombia and Petroamerica Oil Corp. These two firms recently acquired 10% and 15% stakes, respectively, in a farmout process Petrobras held in the middle of last year.

## Petrobras in Colombia

Petrobras began its operations in Colombia in 1972, in an exploratory project that marked the beginning of the company's international operations. In the Exploration & Production segment, the Company currently holds stakes in seven production fields (five of which it is the operator of) and 20 exploration blocks (as the operator in nine) in the country. Petrobras also distributes and markets Petrobras Lubrax lubricants and fuel, and operates a network of 74 service stations there.

In the Exploration & Production segment, the Company currently holds stakes in seven production fields (five of which it is the operator of) and 20 exploration blocks (as the operator in nine) in the country.

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## Editorial 2010 Calendar

| Jan/Feb | April/May | July/August | Oct/Nov |
|---|---|---|---|
| • Tupi & Subsalt<br>• Deepwater and Subsea Technology<br>• Cementing<br>• LWD / MWD<br>• Energy Efficiency<br>• Smart Well Innovations<br>• Real Time Operations<br>• Software Consulting for Oil, Gas and Reservoirs Exploration | • Onshore Fields<br>• Completion Technology<br>• Smart Fluids<br>• Formation Evaluation<br>• Expandables<br>• Tubulars<br>• Drill-Pipe<br>• Casing Drilling<br>• Campos Basin & New Seismic Frontiers | • Petrobras President Interview<br>• Reservoir Visualization<br>• Extended Seismic Feature (4D, OBC, Wide Azimuth)<br>• Reservoir Characterization<br>• Well Intervention<br>• Pipeline<br>• Pigging and Pipeline Testing | • Multi-laterals<br>• MPD Managed Pressure Drilling<br>• Controlled Source Electro Magnetic<br>• Zonal Isolation<br>• EOR (PRAVAP)<br>• Heavy Oil (PROPES)<br>• Petrobras Offshore Construction<br>• PROSAL Cenpes |
| **Bonus Circulation** | | | |
| | **SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production**<br>12-14 April 2010<br>Rio de Janeiro<br>Brazil<br><br>**72nd EAGE Conference & Exhibition/ SPE EUROPEC 2010**<br>14-17 June 2010<br>Barcelona<br>Spain | **2010 Rio Oil & Gas**<br>13-16 September<br>Riocentro<br>Rio<br>Brazil<br><br>**SPE Annual Technical Conference and Exhibition**<br>20-22 September 2010<br>Florence<br>Italy | |
| **Special Publications** | | | |
| | Petrobras Pre-Salt Technologies | Petrobras Technology III | |

# Brazil's New Oil & Gas Regulatory Framework – Production Sharing Agreements in the Pre-Salt Area

By Marcos D. Panassol, Oil&Gas Segment Country Leader of PricewaterhouseCoopers in Brazil.

One of the items included in the new Oil & Gas Regulatory Framework unveiled by the Brazilian Federal Government last year and currently under discussion in the Congress, relates to the implementation of Production Sharing Agreements, or "PSAs", for the exploration, development and production of hydrocarbons in the Pre-Salt area.

PSAs have been utilized in over 40 countries, usually those in the development stage with restricted access to financial resources and technology. Under this type of contract, the State, usually the owner of subsoil resources, retains an oil company to provide financial and technical resources to explore the area under contract. All risks related to the exploratory phase (such as no discovery or discovery that is not commercial) are borne by the oil company. When commercial reserves are found, developed and produced, then the first oil produced is applied to the recovery of costs (cost oil), the remaining oil produced being shared by the Government and the oil company (oil profit) on a predetermined basis. The PSA can be very interesting for both governments and oil companies, as it provides access to the finances and technology required to extract the mineral resources, otherwise not easily available to the countries, and also provides access to new reserves for the oil companies. On the other hand, there will always be tension between the parties, as governments will seek to maximize revenues (e.g. from oil and related taxes) and oil companies will try to maximize their profits through reduction of costs, optimization of commercial strategies and reduction of taxes.

In the case of Brazil, the Regulatory Framework established that government interests in the exploration, development and production of the Pre-Salt areas will be represented by a company yet to be created (currently known as Petrosal), which will participate in the operating committees of all these areas with a veto power. In addition, the state-controlled oil company Petrobras will participate with at least 30% in all Pre-Salt areas and will also be the operator in such areas. Therefore Petrobras, as a state-controlled oil company, will have a dual role in the contracts: a) as a government agent, which is inherent to its position, and b) as an oil company competing with other oil companies for the PSA contracts. These facts combined are of extreme importance in the discussion of the implementation of the PSA in Brazil, not only for the contracts themselves but also for the tax system to be implemented and the accounting for the exploration and development costs.

Oil companies can add significantly to the cost efficiency of the exploratory projects bringing their experiences from around the world and even considering the uniqueness of the Pre-Salt areas. Also, they will expect to be able to book their share of the reserves as their own, as the value of an oil company is heavily tied to the amount of its reserves and its capacity to replace production with new reserves.

Therefore, discussion of the terms of the contracts will have to include models and provisions detailing all the inherent risks relating to the exploratory activity previously mentioned, as well as the development risks (unexpected increased costs of equipment, of financing, etc), and the different taxation levels (royalties, special participation, other direct and indirect taxes, etc), the impact of which is not clear at this moment.

In conclusion, the expected approval by the Brazilian Congress of the new Regulatory Framework will be only the beginning of an extraordinarily complex process of bringing the PSA model to reality in the Brazilian Oil & Gas industry.

# Fugro Brasil Keeps Growing

By Fugro Group

Founded in Holland in 1962, Fugro operates around the world, collecting and interpreting data related to the earth's surface and the soils and rocks beneath, for purposes mainly related to the oil & gas, mining and construction industries, using professional, highly specialised staff supported by advanced technologies and systems, many of which have been developed in-house. The company name is derived from the Dutch words "FUnderingen en GROndmechanica", which means Foundation and Soil Mechanics.

Fugro has been steadily growing over the years, both organically and through acquisitions, governed by defined general businesses principles, which express their values vis-à-vis shareholders, customers, employees, business partners and society at large. With approximately 13,500 employees and a presence in more than 50 countries, the Group businesses are divided in three divisions, as below:

- **GEOTECHNICAL DIVISION**
  Onshore Geotechnics
  Offshore Geotechnics

- **SURVEY DIVISION**
  Offshore Survey
  Geospatial Services
  Subsea Services

- **GEOSCIENCE DIVISION**
  Information Services
  Seismic Services
  General Geophysical Services

## Presence in Brazil

Fugro has been actively working in Brazil for more than 20 years, always combining focus on customers and commitment to QHSE. Together with Fugro Brasil, the following Fugro operational companies are based in Brazil:

**FUGRO BRASIL** – Serviços Submarinos e Levantamentos Ltda.
*Positioning, Survey, Diving, ROV, Metocean and Environmental Services*

**FUGRO GEOSOLUTIONS** Serviços de Levantamentos Ltda.
*Seismic Data Interpretation/Integration and Information Services*

**FUGRO IN SITU** Geotecnia Ltda.
*Geotechnical Onshore Testing, Laboratory Tests and Analysis*
*Geotechnical Nearshore Services*

**FUGRO AIRBORNE** Surveys LASA Prospecções S/A
*Magnetic, Radiometric, Gravity and Electromagnetic Airborne Surveys and Ground Geophysics*

## Fugro Brasil – Serviços Submarinos e Levantamentos Ltda.

Being the largest Fugro company in Brazil, Fugro Brasil has grown significantly and consistently over the past years, focused on the oil & gas sector. Fugro Brasil is also proud of being one of the first companies in the subsea market to achieve triple certification for (ISO 9001, ISO 14001 and OHSAS 18001).

**Integrated/Bundled Services**

Offering a wide portfolio of services, including Positioning, Geophysical Survey, ROV (Remotely Operated Vehicles) operations, Diving (both air and saturation), Metocean and Environmental Services, Fugro Brasil is capable of providing integrated solutions to their various clients.

"Customers are always trying to hire as many combined services as possible, in order to reduce interfaces and risks to manage several different service providers and scope of works that are not always able to fulfil their demands entirely, when put together", says Paulo Cesar Martins, Marketing Diretor of Fugro Brasil. "We have several services to offer to our clients as bundled services, in a 'one stop' shopping approach. These also include specialised services provided by Fugro companies outside Brazil, but that rely upon the local infrastructure made available by Fugro Brasil to service the Brazilian market. Fugro has just launched an initiative aimed at tackling multi-faceted projects in a totally integrated

Fugro Brasil are recognized in the market for their ability to identify and develop win/win partnerships. They have long-term agreements with several ship-owners to run some of their RSVs (ROV Support Vessels) and DSVs (Diving SupportVessels) contracts.

manner, giving the client a single point of contact for all the service elements," indicates the director.

## Infrastructure

Talking about infrastructure, Fugro Brasil has just sent a clear message that we are fully committed to the Brazilian market and are strategically thinking about the long run, with the newly built Rio das Ostras Site. The new site (pictured) was built at the Rio das Ostras ZEN (Especial Business Zone), bordering Macaé. "To be able to lead the market, we cannot only be counting on state-of-the-art technology that we have with some of Fugro's in-house designed and built products such as Starfix integrated software package, the FCV 3000 ROV and Echo Mapper AUV, but we also need to provide a good working environment to our staff, enabling them to develop their work in a high level of professionalism. That is why we have developed the new base, complete with both office and the warehouse facilities"

## Local Content

Another highlight for Fugro Brasil is their level of local content. "Out of almost 800 employees, our company has only four non-Brazilian employees. Our staff is highly trained in-house, using several courses made available through our global training program, called Fugro Academy. Fugro Academy runs several training courses, from very technical and specific basic training up to senior management development."

"We also have our Brazilian flag dedicated research vessel, named *Fugro Odyssey*, that is fully equipped to cover geophysical surveys (including multibeam and 2D high resolution systems), metocean and environmental projects. The vessel is audited at least twice a year, and fulfils all oil majors' safety requirements," says Paulo Martins.

## Partnerships

Fugro Brasil are recognised in the market for their ability to identify and develop Win/Win partnerships. They have long-term partnerships with several ship-owners to run some of their RSV (ROV Support Vessels) and DSV (Diving Support Vessels) contracts. Paulo Martins comments: "We understand that it is sometimes better to combine efforts, where each party takes care of a part of the total scope, in line with their respective core businesses."

# Tupi Extended Well Test – the Pre-Salt Province in

Reprinted with permission from Petrobras Magazine

1st May 2009 entered the history of Petrobras, of Brazil, and of the global oil scenario. On this day, the Tupi Extended Well Test began and the first oil was extracted from the Pre-Salt province in the Santos Basin. The production was directed to the FPSO* *BW Cidade de São Vicente* in the presence of the Brazilian minister of Mines and Energy, Edison Lobão; the president of Petrobras, José Sergio Gabrielli de Azevedo; the company's board of directors; and Petrobras partners in the exploratory block, representatives of the British Gas Group (BG), which holds a 25% stake in Tupi, and Galp Energia, with a 10% interest.

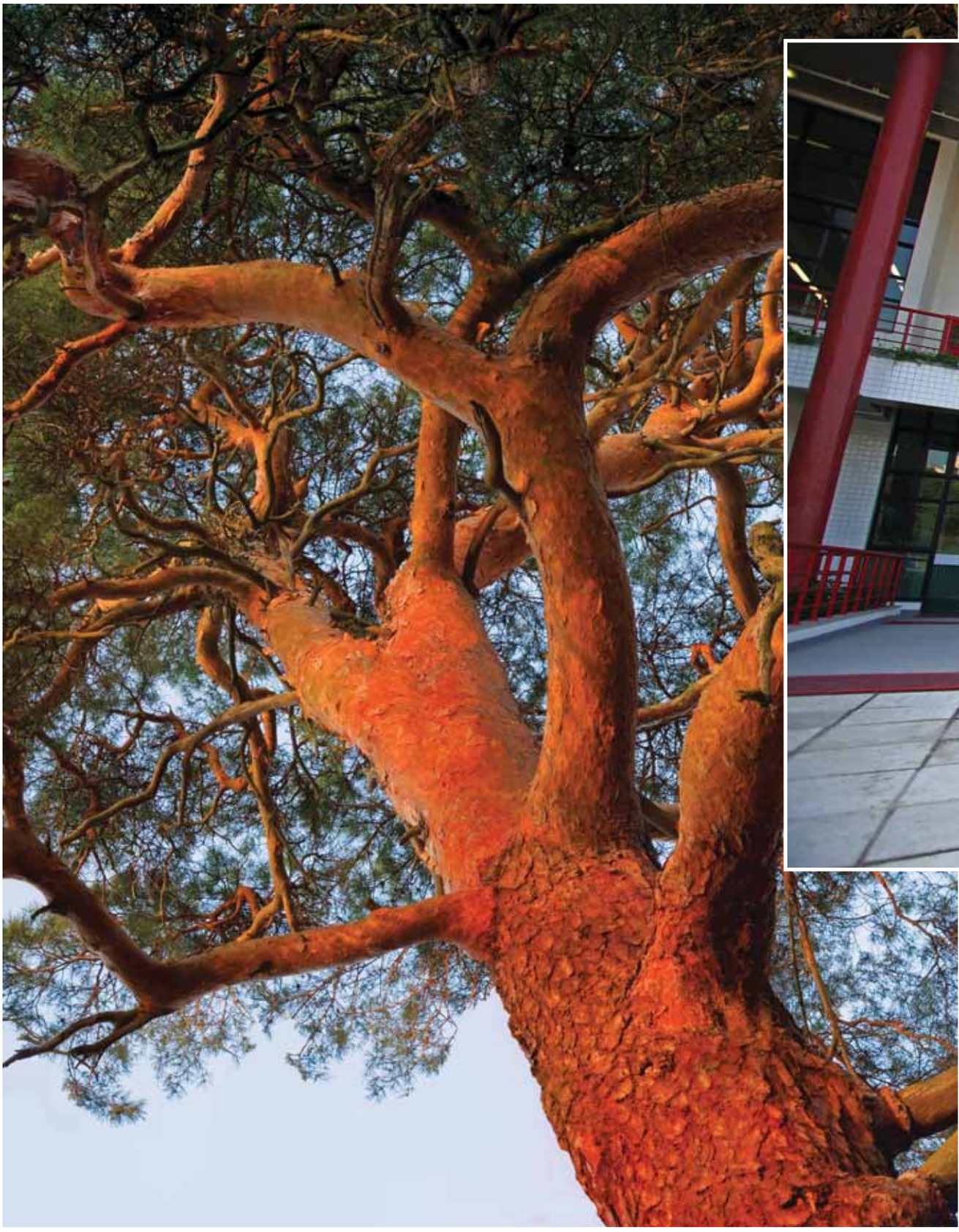
That afternoon, a sample of the oil was presented to the president of Brazil, Luiz Inácio Lula da Silva, in a ceremony in Rio de Janeiro. As usually happens in the passing of the Olympic torch throughout the world, a miniature barrel containing the oil extracted from Tupi was carried by ex-employees of Petrobras and delivered successively into the hands of Brazilian civil organization leaders and celebrities in music, soccer and cinema until final delivery to the head of state.


## The first oil was extracted from the pre-salt province in the Santos Basin

The oil extracted was prospected at approximately 300km from the coast, at more than 5,000m below sea level, or, more precisely, below a water depth of 2,140m and another 3,000m below the sea bed, going through a layer of salt 2,000m thick. This extraction marked the beginning of the development of the largest oil deposit discovered by Petrobras in Brazil. After all, the preliminary estimated volume of recoverable oil equivalent in Tupi is five to eight billion barrels. The oil is light, 28°API, and quite valuable on the international market.

"The Tupi Extended Well Test in progress consists of the sequential production from wells RJS-646 and RJS-660. The purpose is the evaluation of the production from carbonate reservoirs, still without parameters in world history. The performance of fluids in the reservoir and damage to the wells and to the submarine flow lines, among other

# First Oil Extracted from the Santos Basin



items, will also be evaluated in order to optimize the pilot project and the definitive systems foreseen for Tupi. This evaluation will make possible a better understanding of the distribution and geometry of the wells, of the type of completion work necessary and of the most appropriate materials for the wells, production lines and risers, as well as of the development of the best systems for the interconnection of the risers with the FPSO. The production

obtained will be sent to the FPSO *BW Cidade de São Vicente*, a unit with a processing capacity of up to 30,000 barrels of oil per day and a storage capacity of 350,000 barrels of oil. The test is expected to last 15 months and is part of the phase of the collection of geographical and production data," explains Alberto Sampaio de Almeida, assistant to the executive manager of the Petrobras Exploration and Production in the Pre-Salt area.

Still in the information-gathering phase, the Tupi pilot project will begin between October and December of 2010. It will be subdivided into two phases, with an installed production capacity of 100,000 bpd and 5,000,000m³/d of gas. At this time, the FPSO *BW Cidade de São Vicente* will be replaced by the FPSO *Cidade de Angra dos Reis*, currently in a Chinese shipyard, for the adaptation and installation of process plant modules.

In the first phase of the pilot project, the FPSO *Cidade de Angra dos Reis* will be interconnected with five or six producing wells, two water injectors, and a gas and $CO_2$ injector. A gas pipeline of 216km will transport the gas produced to the Mexilhão platform, from where it will be taken to the Monteiro Lobato Gas Treatment Unit, in Caraguatatuba, in the state of São Paulo.

In this first phase of the pilot project, which will last until 2012, tests will be carried out in practice on innumerable items, mechanisms and procedures, for the purpose of anticipating information about production, recovery and oil flow mechanisms, and the integrity of materials, among other topics. Therefore, it will be possible to gain a better understanding of the scenario and to reduce the risks in future production systems.

"During this period, the performance of the secondary oil

recovery methods, such as water injection, gas injection, or water and gas alternatively into the reservoir, will be monitored. The pressure throughout the reservoir, both vertical and horizontal, will be observed. Different well geometries, that is, vertical, inclined, and horizontal, for example, will be tried.

Different forms of well stimulation, such as the injection of acid to dissolve carbonates and enable the well to produce better, will be implemented, to verify the results. The oil flow through submarine pipelines at low temperatures will be observed, so as to monitor the possible deposit of paraffin and the formation of hydrates. The frequency which will be necessary to launch PIGs through the annular lines, making them return through the production lines, in a looping operation, so as to clean them, will be evaluated. The integrity of the production and injection risers will also be tested throughout the period," explains the manager of Conception and Alignment of Projects for the Exploration and Production in the Pre-Salt area, Antonio Carlos Capeleiro Pinto.

Special care will also be taken to prevent the liberation of $CO_2$ coming from the producing reservoir into the atmosphere, since this gas contributes to the formation of the greenhouse effect and global warming. "We will monitor the operation of the $CO_2$ capture and sequestration plant installed on the platform, reinjecting the $CO_2$ to increase the recovery of the reservoir and we will avert corrosion using special steel alloys in the lining of the well production columns, in subsea production equipment, and in components of the processing plant installed on the platform," clarifies Capeleiro Pinto.

## Tupi will enter the final development phase in 2017

In the second phase of the pilot project, which will run from 2012 on, the FPSO will already be operating with the definitive system. At that time, between 2012 and 2017, in Phase 1A of the development of the Santos Basin Pre-Salt Cluster, if the current forecasts are confirmed, another 10 Pre-Salt Cluster production units will be installed: two pilot units and eight definitive system units. The production units should be constructed in Brazil with some being assigned to Tupi. Consolidated technologies or technologies in the process of consolidation will be used in their projects.

As there will be uncertainties at this point, the production systems will be planned so as to guarantee flexibility in the various drainage solutions of the reservoirs.

The preliminary project of Tupi's future production systems contemplates the interconnection of 20 wells, on average, divided between producers and injectors, in each production unit. "The injection wells will be capable of receiving water and gas alternatively, and one or two of them may be dedicated to $CO_2$ injection. The idea is to start the development with a smaller number of wells

and, as production declines, interconnect more wells until the forecasted total is reached. The oil will be transported by shuttle tankers and later offloaded to deliver the partner companies' oil share," says Pinto.

The final phase of the Tupi development, which is part of Phase 1B of the total development of the Santos Basin Pre-Salt Cluster and which will be initiated in 2017, foresees the intensive application of new technologies and the possibility of unconventional solutions. Among these are the use of dry completion units, multiphase seabed pumping, centralized gas and/or water processing systems, the injection of water alternating with $CO_2$ injection in determined locations to increase the final recovery of oil, and the adoption of shipped liquefied natural gas. Once the current estimates are confirmed, the production in the Santos Basin Pre-Salt Cluster should total 1,000,000 bpd by around 2017.

At present, the production arising from the Tupi Extended Well Test is limited to 14,000 barrels per day because the maximum production flow of gas negotiated with the National Oil Agency (Agência Nacional do Petróleo, Gas e Biocombustíveis – ANP) consists of 500,000 $m^3$/day. The oil produced is transferred to terminals on the mainland by means of shuttle tankers.

Judging by the estimated recoverable volume of oil equivalent from Tupi, which will be further complemented by neighboring deposits in the Santos Basin Pre-Salt Cluster, and by the challenges overcome to initiate production in this environment, such as the drilling of wells through a thick layer of salt, the production of oil at depths in excess of 5,000m, and the great distance from the coastline, among others, it is no exaggeration to say that a new era has begun. It is an era of challenges, some of which are being faced now and others which will arise throughout the work in the Pre-Salt Province. Victories are being achieved thanks to the talent and perseverance of the Petrobras workforce and the support of all Brazilians. After all, the Brazilian government participates in the company and the Petrobras achievements are of and for all Brazilians.

# Testing the Integrity of Pipelines with Combined Magnetic Technologies

Interview with Leonardo Fiorini, technical consultant, Morken Brazil.

The company Morken Brazil, specializing in the integrity of gas, oil and oil derivatives pipelines, has an agreement with IGP (Gas and Petroleum Engineering), Argentina, to represent exclusively the use of combined magnetic technologies for inspection of non-piggable pipelines in Brazil.

To talk about the importance of the agreement for the Brazilian market, we conducted an interview with the engineer Leonardo Fiorini, technical consultant with Morken. The MMM (Metal Magnetic Memory) method besides being efficient, is very affordable and opens a range of options for many Brazilian and foreign companies.

**Q: Brazil Oil and Gas** – What are the physical principles and technology used by the Metal Magnetic Memory method?

**A: Fiorini** – The method is based on the detection of anomalies in the pipeline metal structure, represented by areas of stress concentration. Each metallic grain has a 'magnetic signature' of its own; in other words, it reflects the Earth's magnetic field in a specific way in terms of vector direction. The stress concentrations cause the magnetic field vectors to align in the anomalies regions. Then, the devices used to analyze the Earth's magnetic field detects its interaction with the pipeline. The anomalies are interpreted by discrepancies in magnetograms, generated by the vector sum in these areas. In practice two combined geomagnetic methods are used, the remote and the contact MMM techniques. This unique combination allows the data obtained by remote sensing (without contact with the pipeline) to be refined and anomalies classified by risk criteria.

**Q: Brazil Oil and Gas** – What are the defects and risks that the system can detect in the pipelines and how are they appointed?

**A: Fiorini** – The anomalies are always characterized by levels of strain. Thus, structural damage such as dents, cracks, crevices, weld defects, mechanical failures, constructive failures and wall losses, both for corrosion and mechanical attack, can be detected. The anomalies are positioned by GPS with a longitudinal error of 0.25 meters and are classified qualitatively.

**Q: Brazil Oil and Gas** – Only non-piggable pipelines can be checked by this technology. Why?

**A: Fiorini** – The technology can be applied, in principle, in any metallic pipeline, piggable or non-piggable, buried, aerial or submerged. But its nonintrusive feature makes the application in non-piggable pipelines very unique. In this case, the typical risks arising from the inspection Pigs application are discarded, and the operating costs are reduced.

**Q: Brazil Oil and Gas** – What are the differences between the MMM system and traditional methods of pipeline inspection?

**A: Fiorini** – The technology offered is unique. Other techniques are intrusive, and analyze only the coating, or even just aerial pipelines. MMM is the only internationally certified technology that fully evaluates the condition of the metal, without the need for contact with the pipeline. It's certified by ISO 24497 standard.

**Q: Brazil Oil and Gas** – What are the advantages to Morken Brazil in carrying out the agreement with IGP?

**A: Fiorini** – Morken Brazil has already operated as a partner of IGP for over two years. This partnership has promoted the possibility of offering not only magnetic methods, but a set of inspection solutions for all kinds of pipelines. The team is greatly experienced, has great professionalism and their mobilization is Just In Time. Furthermore, IGP enables Morken exclusively to operate these inspection methodologies nationally.

**Q: Brazil Oil and Gas** – Where has Morken operated the MMM technology, and what has resulted from it?

**A: Fiorini** – In Brazil, Morken has performed in companies of various sectors and pipelines of various types. Among its customers are Arcelor Mittal in Serra/ES, Comgás, Transpetro and Quattor (formerly PQU). The results exceeded expectations in every case, proving the technical capability of the method and teamwork.

# Morken Brasil comemora o sucesso de convênio com a IGP

**Acordo com a empresa viabilizou o oferecimento no Brasil de tecnologias magnéticas combinadas para inspeção de dutos não pigáveis**

*Técnicos fazem avaliação em duto de petróleo: tecnologia eficiente por método não intrusivo*

A Morken Brasil tem motivos de sobra para comemorar. A empresa brasileira, especializada em integridade de dutos, tanto em monitoramento de vazamentos, quanto avaliação da condição do metal, do revestimento e proteção catódica celebra o convênio com a IGP (Ingeniería Gás y Petróleo), da Argentina, para representar com exclusividade o uso da tecnologia MMM (Memória Magnética do Metal) para dutos não pigáveis no Brasil.

A técnica, que tem origem russa, é a única internacionalmente certificada para avaliação da estrutura metálica do duto sem a necessidade de mudar as condições operacionais do duto ou desenterrá-lo. É certificada pela norma ISO 24497. Tanto dutos pigáveis quanto não pigáveis podem ser inspecionados.

Uma das principais vantagens da técnica MMM, em relação a outras tecnologias, é a redução de cerca de 70% nos custos da inspeção e o ganho de 40% no tempo total de serviço. A tecnologia permite detectar problemas internos e externos em dutos ferromagnéticos como trincas, fissuras, defeitos em soldas, pontos de corrosão, amassados e outros tipos de concentrações de tensão, incluindo os causados por deslocamentos de terra onde o duto se encontra.

A celebração do convênio com a empresa argentina capacita definitivamente a Morken Brasil para atuar no segmento. A empresa brasileira, com sede na cidade de Campinas vem aplicando a técnica de inspeção em cases de sucesso no país, como a Arcelor Mittal (antiga CST), em Serra-ES, a Comgás (faixa de gasoduto), a Transpetro (terminal marítimo) e a Quattor, empresa que foi adquirida recentemente pela Braskem.

"O sistema MMM, apesar de ser antigo, (teve suas primeiras aplicações em dutos durante a 2ª Guerra como um "radar" para detectar submarinos inimigos) é quase uma revolução quando falamos em detecção e prevenção de danos em dutos não pigáveis. Por ser um sistema relativamente simples, muitas empresas podem optar por esta tecnologia, que além de ser muito eficiente, oferece custos bastante atraentes", ressalta Sergio Ricardo Nogueira, Gerente Nacional da Morken Brasil.

### Como Funciona

O MMM tem como base de que toda a estrutura ferromagnética possui uma espécie de "assinatura" magnética única, gerada pela interação de cada grão metálico com o magnetismo terrestre. Qualquer dano ao duto cria uma concentração de tensão, que acarreta num alinhamento dos vetores magnéticos na região Este alinhamento faz com que o geomagnetismo avaliado pelo sensor remoto seja de amplitude maior no local das anomalias. Além disso, o formato do magnetograma (o gráfico que representa a interação do duto no geomagnetismo) traz inúmeras informações.

O trabalho começa com o levantamento das especificações e condições operacionais do duto para análise de viabilidade técnica. O sensoreamento magnético é realizado, na prática, pela combinação de duas técnicas, o MMM de forma remota e o MMM de contato. Esta combinação faz com que os dados obtidos remotamente sejam refinados e as anomalias classificadas em grau de periculosidade.

### Morken Brasil

A Morken é uma empresa latino-americana, com operação na Argentina, Bolívia, Peru e Brasil. Além disso, tem escritórios no Uruguai, Chile e Equador através de parceiros. Foi fundada na Argentina em julho de 1979 e está no Brasil desde dezembro de 2007.

Para saber mais detalhes sobre os produtos e serviços da Morken Brasil basta acessar o site:

**www.morkenbrasil.com.br**

Os telefones para contato são:

**Campinas/SP - 55 (19) 3288-0644**
**Rio de Janeiro/RJ - 55 (21) 2498-5125**


# Practical Pigging Training Course from CTDUT

CTDUT – Pipeline Technology Center, concluded, in April, the third Practical Pigging Training Course, a five-day hands-on course covering safety and the practical aspects of pipeline pigging.

The training course has been developed to provide a wide-ranging overview of all aspects of pigging operations, with a strong emphasis on safety. Initiated in April 2009, the course is held twice a year at the CTDUT facility adjacent to Petrobras Duque de Caxias refinery, near Rio de Janeiro.

Currently, the course uses the 14-in, 120-m long, water-driven test loop at the site, but from 2011 it will be adapted to use the 2.5-km long 12-in crude oil and 16-in gas test loops which are currently under construction.


The content of the course has been developed jointly by Penspen, CTDUT, Clarion Technical Conferences and Tiratsoo Technical. The Brazilian company with activities in oil and gas pipe inspection PipeWay Engenharia agreed to provide cleaning, geometry and intelligent tools for use during this edition of the course, along with the support of their expert technicians. In a previous edition, Rosen provided the inspection tool.

"When I knew, some years ago, about the existence of CTDUT, I immediately perceived the chance to develop the Practical Pigging Training Course," says John Tiratsoo, from Clarion/Tiratsoo Technical. "No such facility exists, today, anywhere in the world."

The primary aim of the course is to provide a practical understanding of how pigging operations of all types can be carried out safely. Among the subjects covered are: pig trap doors and launch/receive trap design, types of utility and intelligent tools, launching and receiving utility and intelligent tools, how to assess a tool's performance, signalling and pig locating, locating and reporting sample defects, and safety procedures and performance.

The training course includes both hands-on pig run using the test loop(s), and classroom instruction, and provides full documentation.

"Before CTDUT, for a professional out of Petrobras or another operator, it was impossible to participate in a practical course like this," says Vinicius Lima, operations manager at Pipeway Engineering. "This course is open to the pipeline community, and it offers an excellent chance for those entering the market or searching for improvements."

The course has had professionals participating from countries like Venezuela, Colombia, Bolivia, Peru, Mexico, the Netherlands and Portugal.

"Our company specializes in preventive engineering in civil construction. We have opportunities in Africa in the pipeline inspection, maintenance and cleanness area," says Tiago Reis, engineer with Spy Building Oil & Gas, of Portugal. "We have invested strongly in qualification. We participated, last year, in an event at Clarion in Canada. It was then that we heard about this course in CTDUT."

## A Full Scale Research Laboratory

Located in Rio de Janeiro, the heart of Brazilian oil and gas industry, CTDUT (Pipeline Technology Center) is a shared research and testing full scale facility dedicated to the development of the pipeline sector,. Its infrastructure offers technical and economical advantages both for suppliers and operators, which may, for instance, test new technologies without risking their own operations.

Products and services offered include PIG testing and evaluation, pressure testing on pipes, flow meters and


leakage detectors, claddings, coatings and linings, as well as pumps and valves, making the Center the perfect place for demonstrations, as well as training and capacity-building courses.

Inaugurated in May 2006 as a private non-profit association, CTDUT arose from an initiative undertaken by Petrobras, Transpetro and the Pontifical Catholic University in Rio de Janeiro (PUC-Rio). Nowadays, it boasts a significant number of members, including companies, universities and other R&D institutions. Its facilities were built with resources from the Oil and Gas Sector Fund (CTPetro) which is managed by the Ministry of Science and Technology (MCT) through the Studies and Projects Financing Agency (FINEP).

## CTDUT to build a pilot test unit in cathodic protection

CTDUT and Petrobras have signed a cooperation agreement that will make possible the construction of a Pilot Test Unit in Cathodic Protection, Anticorrosive Coating Research and Evaluation in Pipelines in Brazil.

The unit will be constructed in CTDUT (in an approximate area of 1.000 $m^2$) and will allow the carrying out of tests and the simulation of situations found in the field, through the installation of embedded, coated pipelines with different types of anticorrosive coatings, protected by a system of cathodic protection, composed of rectifiers, stream beds of anodes and checkpoints.

"With this structure we are able to simulate techniques very similar to the ones found in the field, making possible the evaluation of new technologies and new practices, besides the study of today's existing situations in order to increase the understanding of possible problems and their solutions," says the Executive Chairman of the board of CTDUT, Raimar van den Bylaardt.

The idea is to inaugurate the unit on September 24, 2010, when we commemorate the six years of the foundation of the Brazilian Center for Pipeline Technology. "This infrastructure has the main objective of supporting research and development (R&D) projects, projects for companies, universities and technology centers," he says. "The market for the application of this technology is sufficiently wide. We have transportation and distribution companies, companies that hold onshore or offshore pipelines and service and equipment companies in the area of cathodic protection, several of them being CTDUT associates."

Moreover, this installation will meet the requirements of the Brazilian NBR 43:000.03 - 001 (Norm for qualification and certification for professionals of cathodic protection) from ABNT (Brazilian Technical Standards Association).

CTDUT has also elaborated the draft Regulation for Safety on Pipeline and Terminals Operation that will be issued by ANP (Brazilian Regulation Agency for Oil & Gas) and will be used as a guideline for pipeline construction, operation, inspection, maintenance and even deactivation.

**Visit our websites:**
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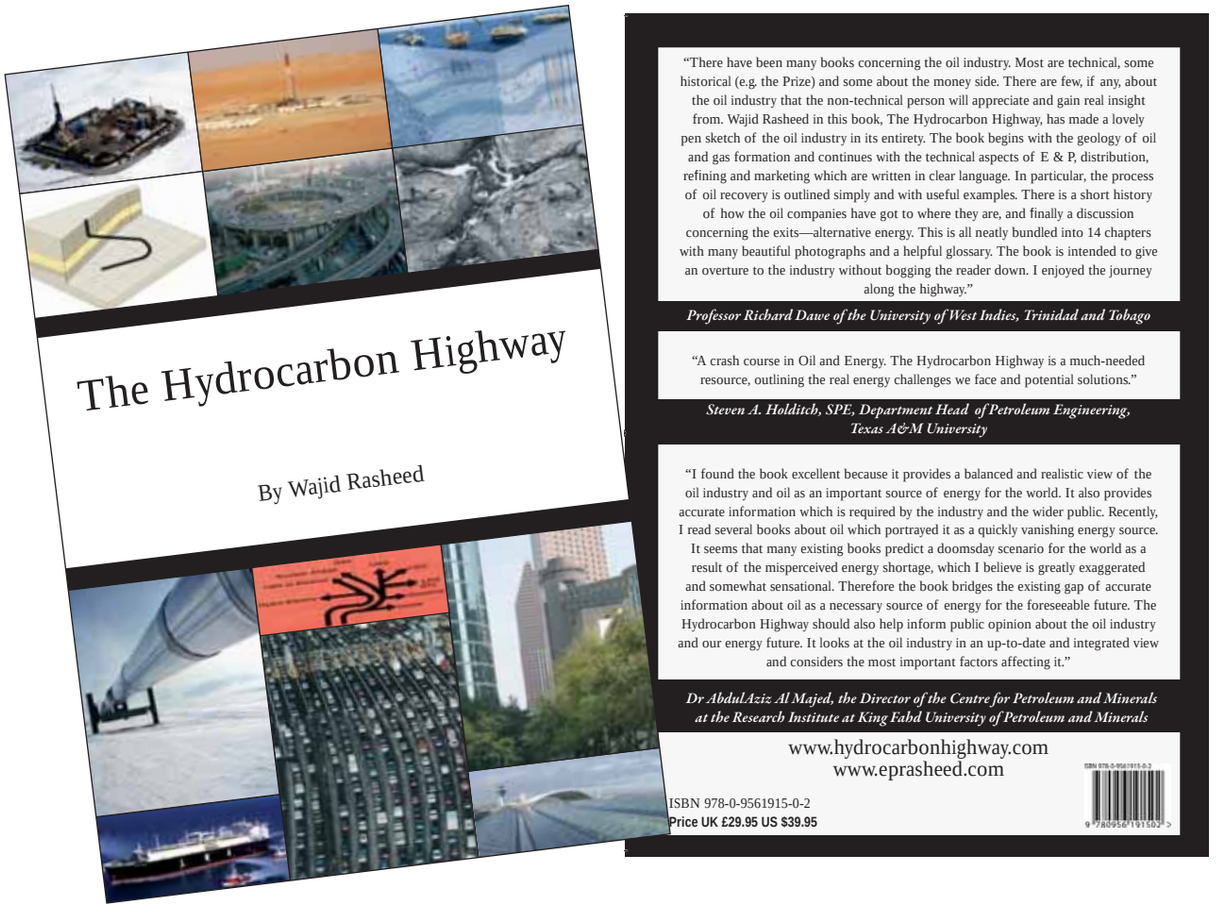
# World Oil and Gas Production

*A Chapter from The Hydrocarbon Highway, by Wajid Rasheed*




*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 placed Saudi Arabia's proven reserves by the end of 2007 as at least 264.2 billion barrels including new finds and the listed mega-projects. This was 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. 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].

## 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].

## 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

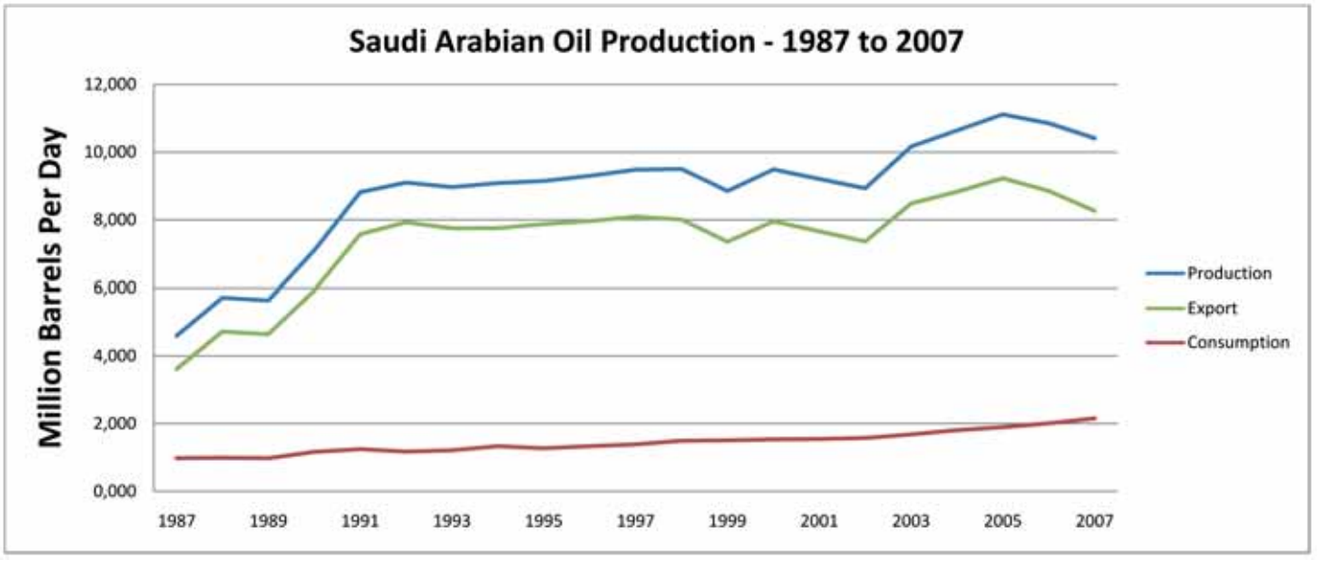



Table 1 - Saudi Arabian Oil Production (1987 to 2007)

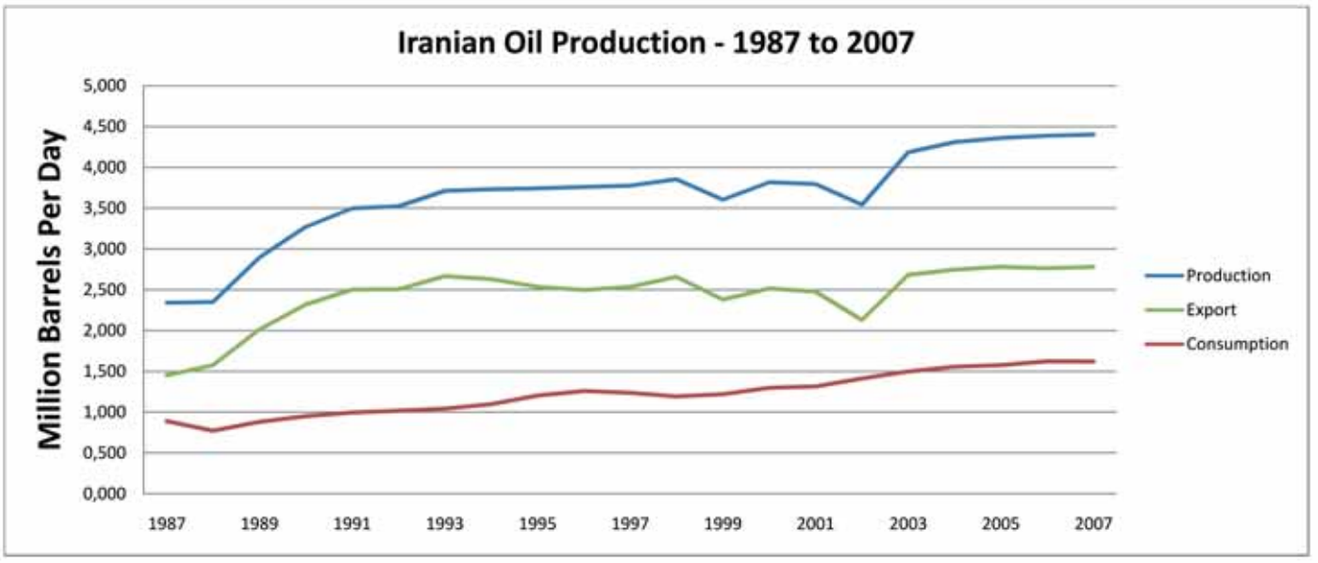



**Table 2 - Iranian Oil Production (1987 to 2007)**

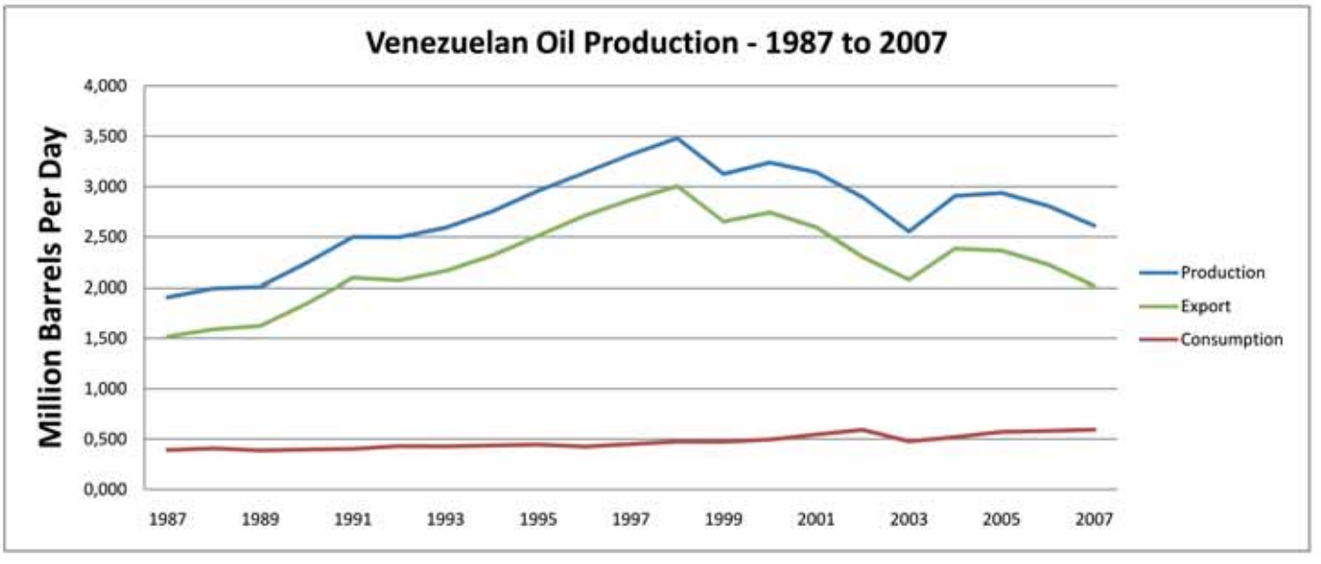



**Table 3 - Venezuelan Oil Production (1987 to 2007)**

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].

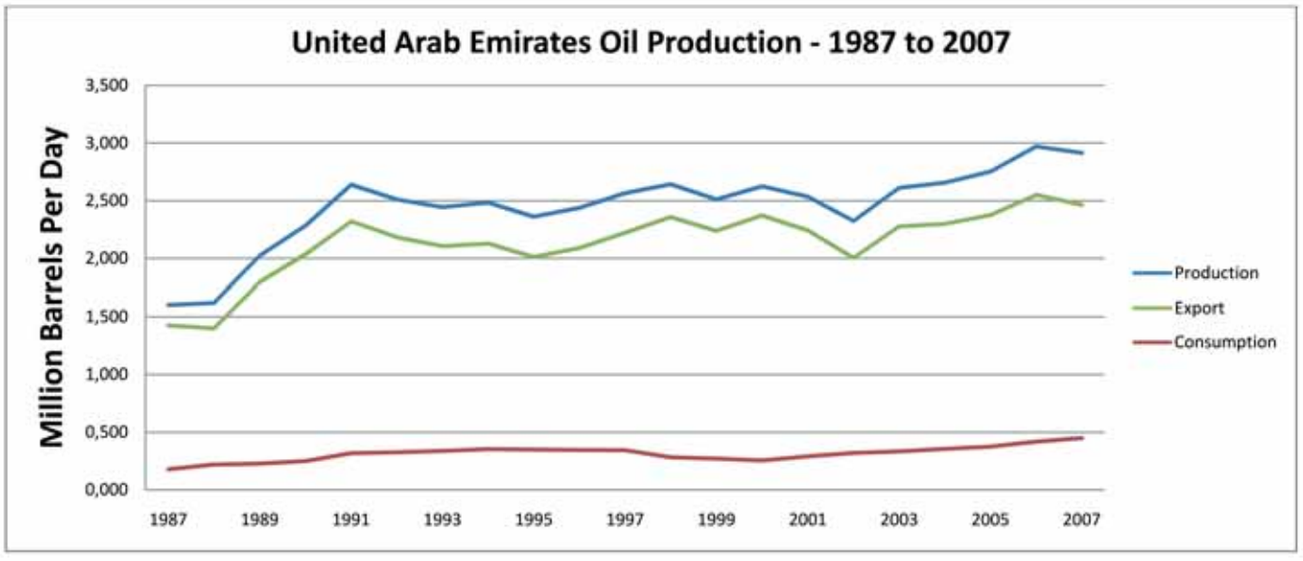



**Table 4 - UAE Oil Production (1987 to 2007)**

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

## 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, 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 21º–45º, with a low sulphur content. Nigeria's marker crudes on the international oil market are Bonny Light and 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

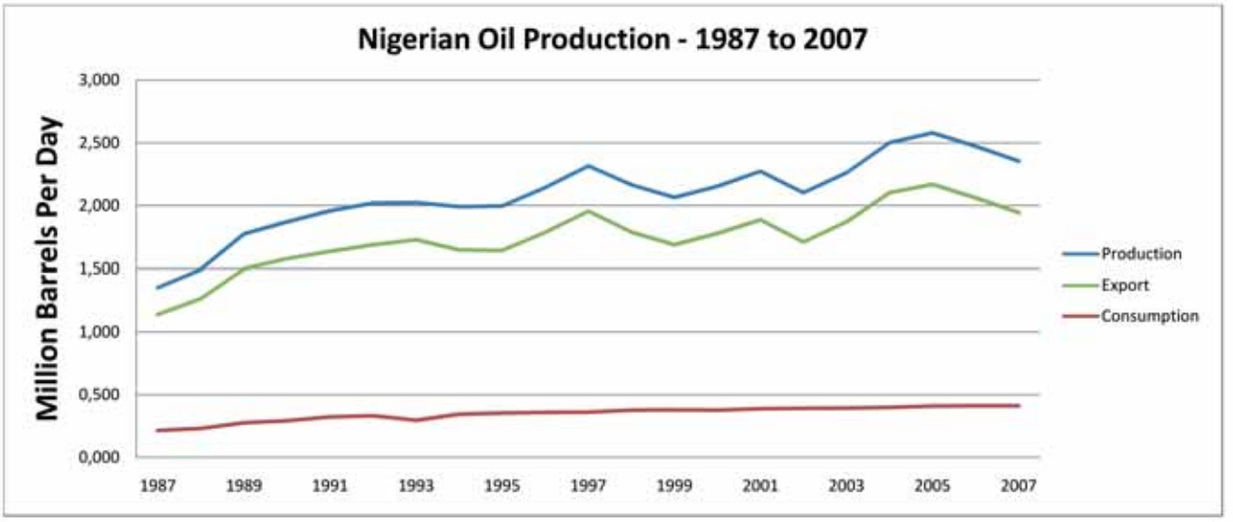



Table 5 - Nigerian Oil Production (1987 to 2007)

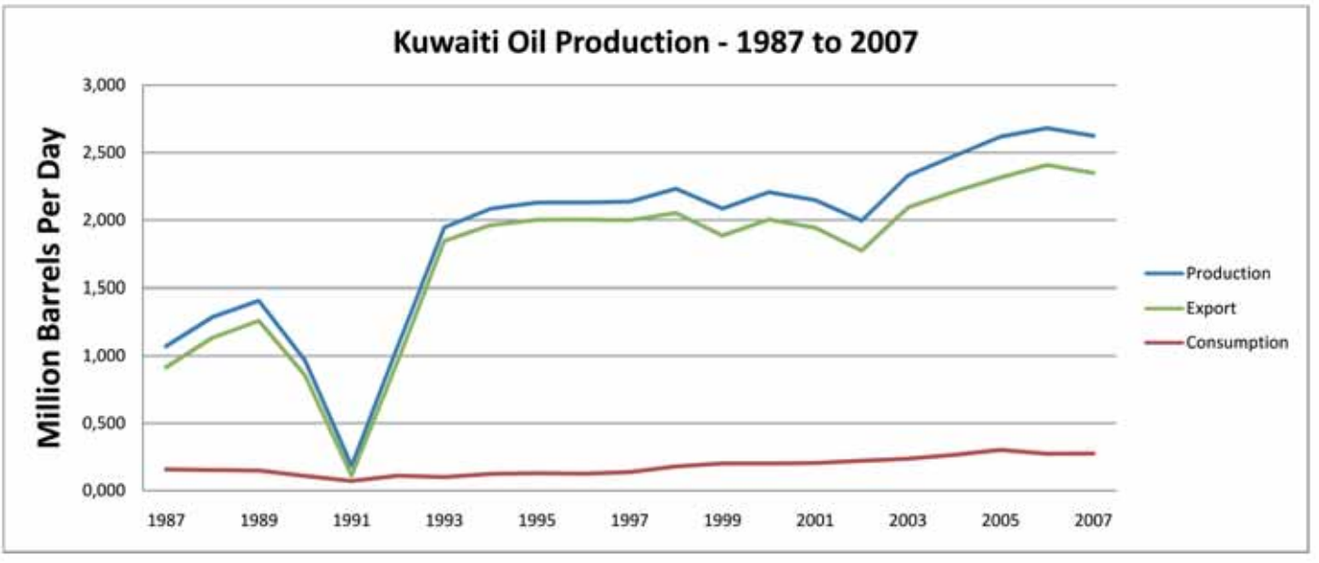



Table 6 - Kuwaiti Oil Production (1987 to 2007)

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.

The Kuwait Petroleum Corporation (KPC) was

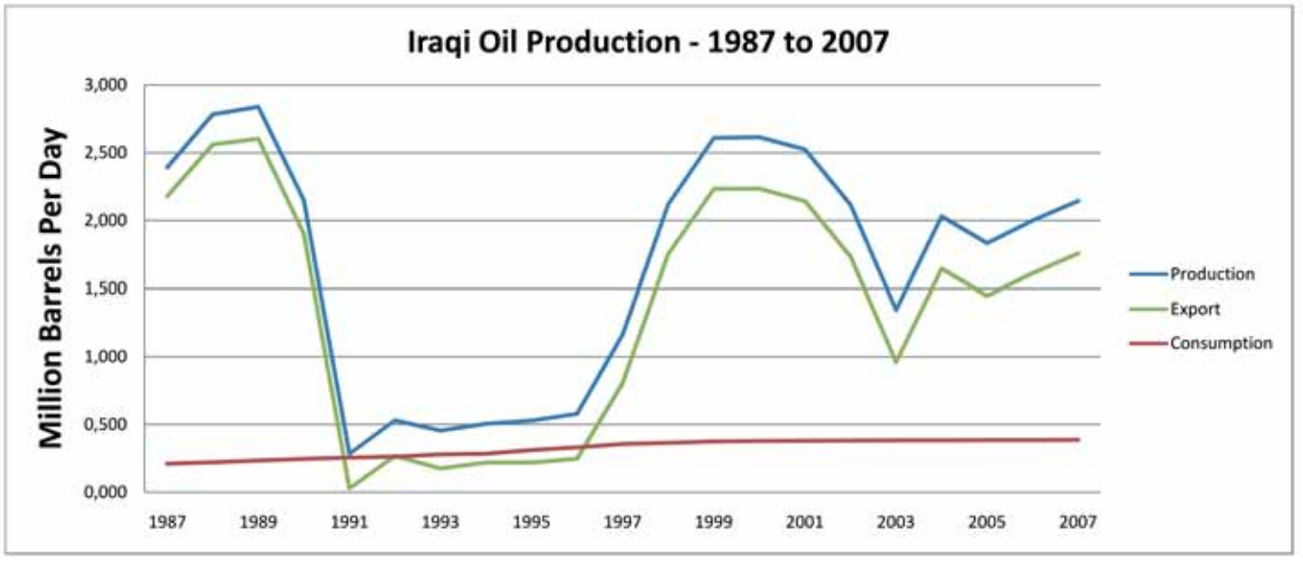



Table 7 - Iraqi Oil Production (1987 to 2007)

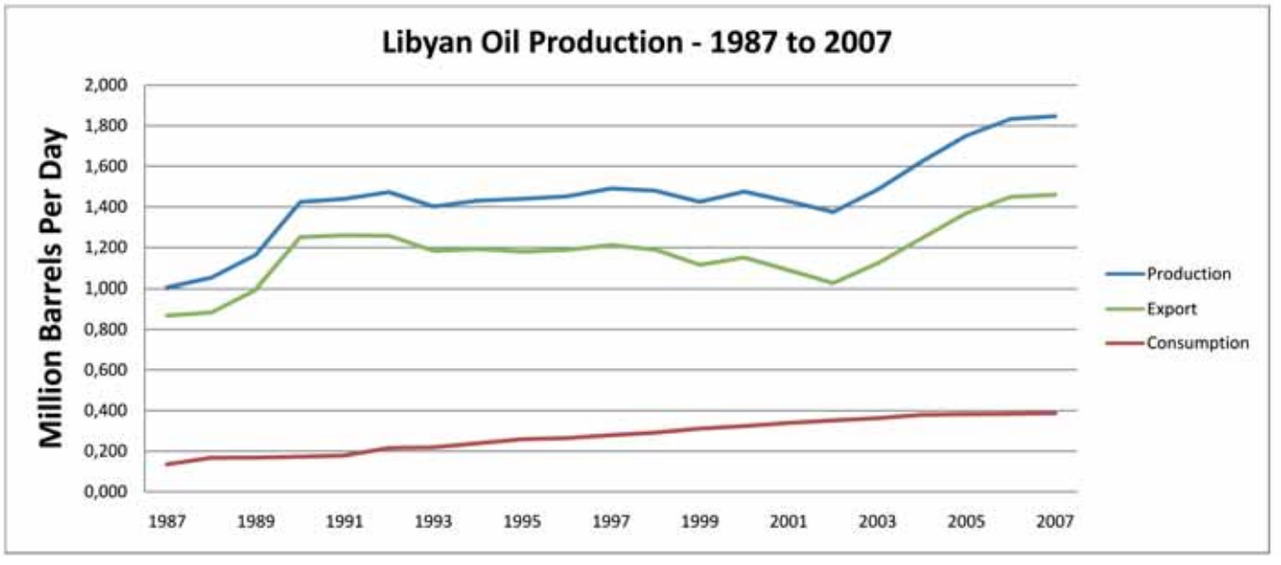



Table 8 - Libyan Oil Production (1987 to 2007)

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.

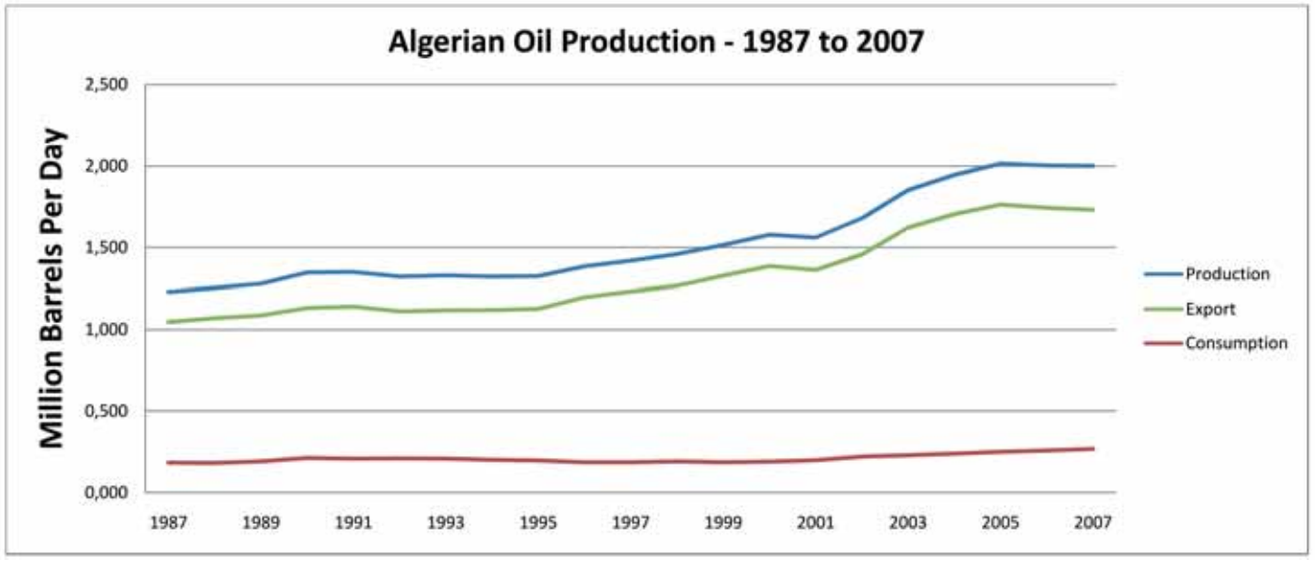



**Table 9 - Algerian Oil Production (1987 to 2007)**

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.

## Libya

In 2007, Libya produced 1.85 MMbbl/d and was estimated to have consumed 0.30 MMbbl/d, thereby exporting 1.55 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 south-eastern 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.

## 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 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 its 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].

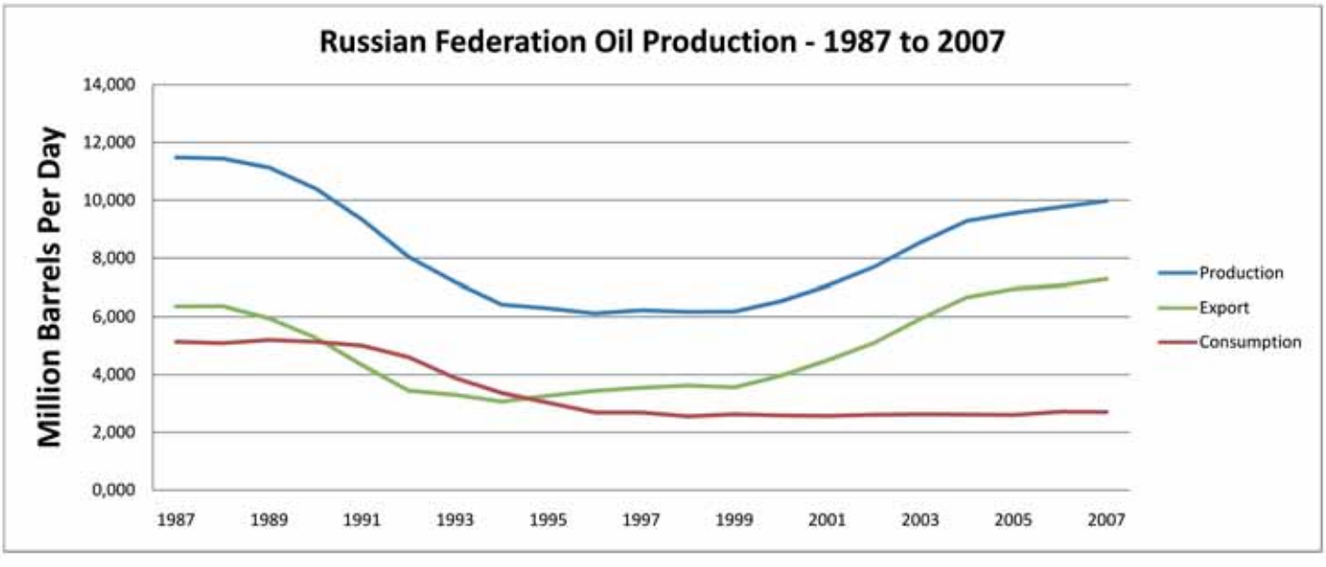



Table 10 - Russian Federation Oil Production (1987 to 2007)

## 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 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% 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 (C1+C2) 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

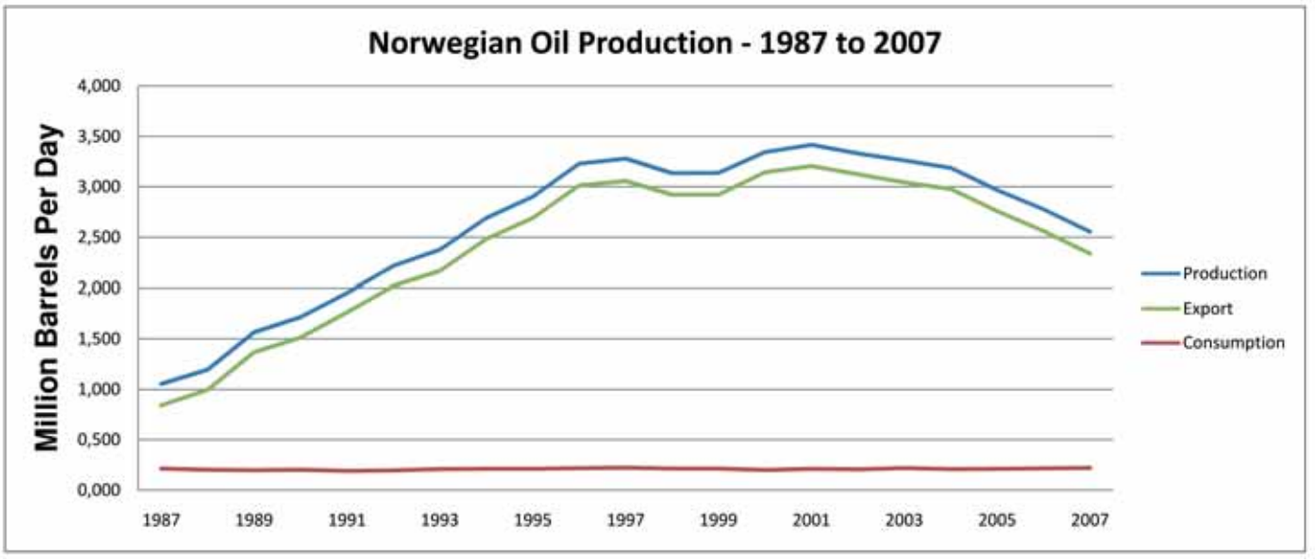



**Table 11 - Norwegian Oil Production (1987 to 2007)**

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].

## 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 com-

pany 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].

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.

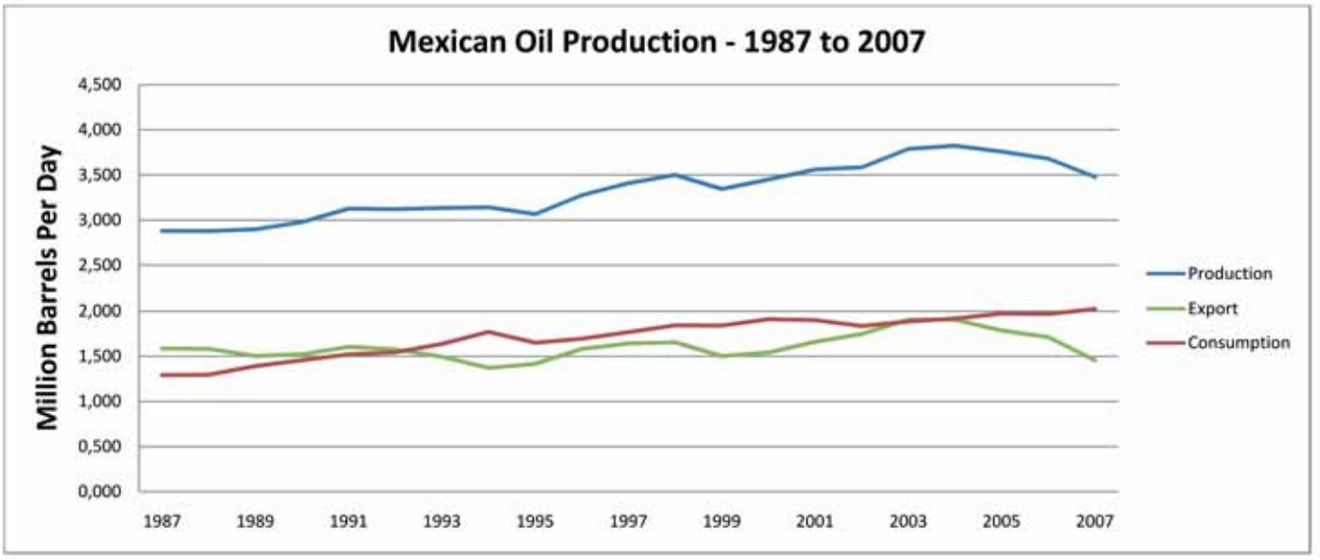



**Table 12 - Mexican Oil Production (1987 to 2007)**

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.

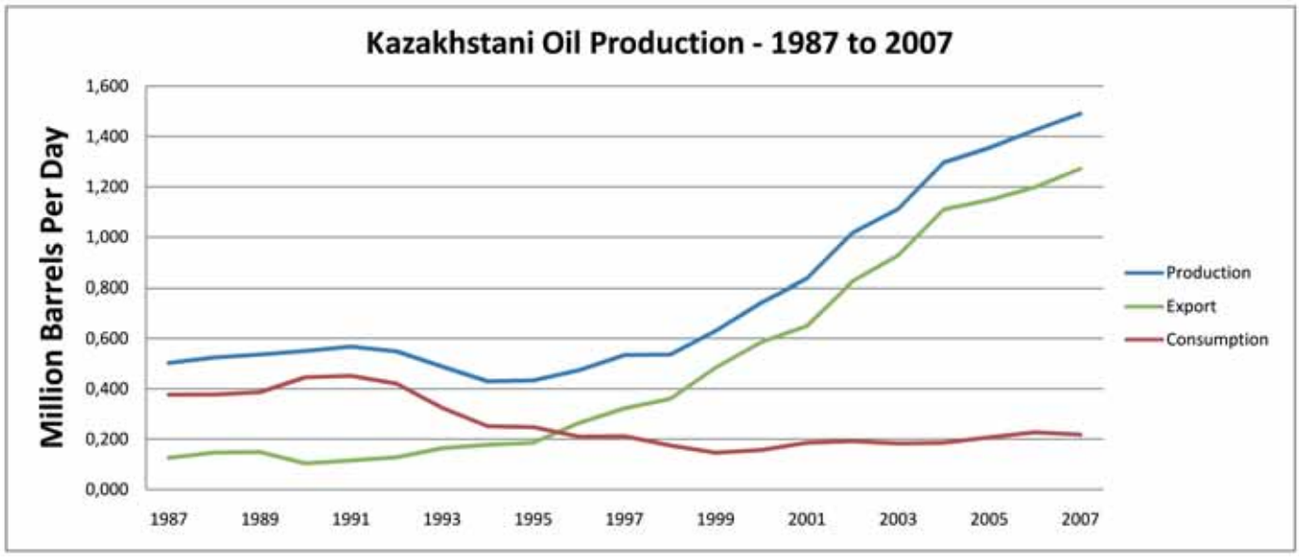



**Table 13 - Kazakhstani Oil Production (1987 to 2007)**

## 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].

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 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?

## References

1. BP Statistical Review 2008 page 8.

2. Considering the contributions oil revenues make to GDP

3. Concerns regarding commercialisation and profitability are the main reasons why insufficient refining capacity.

4. The GECF was widely covered in the press.

5. BP Statistical Review 2008 defined as proved reserves.

6. Saudi Aramco Annual Report 2008. For specifics of technologies see editions of Saudi Aramco Journal of Technology.

7. King Abdullah University of Science and Technology (KAUST) was built in Saudi Arabia as an international, graduate-level research university dedicated to inspiring a new age of scientific achievement in the Kingdom that will also benefit the region and the world. KAUST will be merit-based and will recruit men and women from around the world.

8. BP Statistical Review 2008 page 8.

9. EIA/IEO www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/supply.

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14. PdVSA Annual Report 2008.

15. BP Statistical Review 2008 page 8.

16. Oil wealth has undoubtedly helped the UAE especially Abu Dhabi secure commercial growth.

17. See Dubai's Strategic Plan

18. BP Statistical Review 2008 page 8.

19. See Niger Delta Development Commission Master Plan 2001 which states 'There have been many attempts and many plans made in the past to improve the lives of the people of the Niger Delta Region of Nigeria. Sadly, each ended with very little to show for the time and resources spent. Therefore it is understandable that the people of the Niger Delta are quite disillusioned with 'plans' at this time. The disenchantment of the people not withstanding, it must be stated that the Niger Delta Master Plan is different in its goals, focus and approach, and will not suffer the fate of the others before it'.

20. Depositional Control on Hydrocarbon Accumulations in Deepwater Nigeria By Xijin (CJ) Liu Conoco Phillips Search and Discovery Article #40226 (2006).

21. Kuwait Petroleum Corporation (KPC) Annual Report 2008.

22. Any number for consumption will be controversial for those who require an explanation see "Scramble to carve up Iraqi oil reserves lies behind US diplomacy," Observer, October 6, 2002.

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24. Sarir, Sirte Basin, Desert Surprise Then and Now Some Keys to Revisit of Libya Compiled from articles by

C. J. Lewis (1990) and R. M. Sanford (1970).

25. Framework for the Exploration of Libya: An Illustrated Summary Compiled by Jingyao Gong.

26. Sonatrach Annual Report 2007.

27. BP Statistical Review 2008 page 8.

28. Idem.

29. Idem.

30. OPEC Annual Statistical Bulletin 2008.

31. EIA IEO 2008 outlook.

32. EIA IEO 2008 outlook states Kazhakstan as exporter to note.

33. The deepwater developments are particularly susceptible to the low oil price environment.

34. Perhaps wider co-ordination is simply due to market forces.

35. See Brazil Oil and Gas Issue 3 – Petrobras and Self Sufficiency (www.braziloilandgas.com/issue3 ).

36. BP Statistical Review 2008 page 8.

37. OPEC Annual Statistical Bulletin 2008.

38. EIA IEO 2008.

39. This is a well known fact regarding Canadian Tar Sands.

40. There is no doubt regarding OPEC's future importance.

41. BP Statistical Review 2008 page 18.

42. Idem.

43. The Stabilization fund of the Russian Federation was established on January 1, 2004 as a part of the federal budget to balance the books in the event of the oil price falling below a cut-off price, currently set at US $27 per barrel. Furthermore, the Fund is to serve as an important tool for absorbing excessive liquidity, reducing inflationary pressure and insulating the economy from the volatility of export earnings.

44. Widely reported in the press.

45. Rosneft Annual Report 2008 converted from tonnes.

46. Ditto above.

47. Sakhalin Report 2006.

48. Rosneft Annual Report 2008.

49. GazpromNeft Annual Report 2008.

50. OJSC Noyabrskneftegazgeophysica – Company Profile 2006.

51. Sibneft Annual Report 2005.

52. GazpromNeft Annual Report 2008.

53. Recently Russia is investing more in its Gas infrastructure.

54. Offshore Magazine Feb 1997 RUSSIA Barents Sea still languishing in political limbo Gazprom, Rosshelf, and partners predicting production post-2000 Dev George Managing Editor.

55. Nordstream Facts Newsletter Issue 9/1—2009.

56. Barents Sea field delineated 2008-12-08 StatoilHydro.

57. Idem.

58. CGES Pipeline Advisory Service bulletin No. 23 2006 6th November 2006.

59. Baltic Pipeline System (BPS) was built to transport the crude from fields in Western Siberian, Timan-Pechora and Volga-Urals petroleum provinces to a terminal on the coast of the Gulf of Finland for export. The system includes an existing oil pipeline, which links Haryaga and Usa, trunk pipelines from Usa to Ukhta to Yaroslavl to Kirishi, new trunk pipelines between Haryaga and Usa and between Kirishi the coast of the Gulf of Finalnd, and finally the new oil export terminal in the city of Primorsk.

60. The Federation of Russian States Oil and Gas Activity and Concession Map – 2nd Edition – 2007.

61. Sakhalin-1 Project Receives Award for Excellence from International Petroleum Technology Conference Kuala Lumpur, December 3, 2008.

62. The Norwegian Petroleum Directorate is administratively subject to the Ministry of Petroleum and Energy, and advises the Ministry on matters concerning the management of the petroleum resources on the Norwegian continental shelf. The Directorate holds all the important data in connection with the petroleum activity in Norway, including a complete, up-to-date survey of resources, production, costs and other relevant information.

63. BP Statistical Review 2008 page 8.

64. Norway StatoilHydro shareholders.

http://www.statoilhydro.com/en/InvestorCentre/Share/Shareholders/Top20/Pages/default.aspx

65. Petter Osmundsen Commitment at home and abroad 30.4.2007 Merging Statoil and Hydro's petroleum business will benefit the international involvement of the new company, since size is significant in this business. But any reduction in activity on the NCS would be a very poor socio-economic outcome for Norway.

66. See Petoro Perspective Sveinun Sletten. The Norwegian government has been involved as an owner from the early days of the country's oil adventure – through Statoil and Hydro. And from 1985 also through the State's Direct Financial Interest (SDFI).

67. The Norwegian Petroleum Directorate shall contribute to creating the greatest possible values for society from the oil and gas activities by means of prudent resource management based on safety, emergency preparedness and safeguarding of external environment.

68. The Research Council for Norway, Funding for Petroleum Research Adviser Tor-Petter Johnsen PETROMAKS.

69. Offshore Magazine April 2002 Norway: NKr 46 billion Snøhvit scheme brings LNG to northern Norway By Nick Tedre, Contributing Editor.

70. StatoilHydro Annual Report 2008.

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73. US Country Analysis Brief of Mexico http://www.eia.doe.gov/emeu/cabs/mexico.html

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# Petrobras Production, March 2010

The chart shows the production per Brazilian state and per region abroad in March 2010.

| STATE AND REGION | OIL barrels/day | | | NATURAL GAS thousand cubic meters/day | | | OIL & GAS barrel equiv./day (boe) |
|---|---|---|---|---|---|---|---|
| | ONSHORE | OFFSHORE | TOTAL | ONSHORE | OFFSHORE | TOTAL | TOTAL – BOE/DAY |
| Rio de Janeiro | --- | 1,624,003 | 1,624,003 | --- | 25,437 | 25,437 | 1,783,994 |
| Espírito Santo | 12,391 | 126,307 | 138,698 | 238 | 2,921 | 3,159 | 158,567 |
| Amazonas | 52,744 | --- | 52,744 | 9,667 | --- | 9,667 | 113,548 |
| Bahia | 45,733 | 399 | 46,131 | 2,574 | 2,207 | 4,780 | 76,198 |
| R.G.Norte | 50,561 | 9,681 | 60,242 | 710 | 847 | 1,557 | 70,033 |
| Sergipe | 37,324 | 8,870 | 46,194 | 267 | 2,223 | 2,490 | 61,854 |
| Alagoas | 7,439 | 197 | 7,636 | 1,674 | 244 | 1,918 | 19,703 |
| Ceará | 1,853 | 6,280 | 8,132 | 2 | 111 | 112 | 8,840 |
| Paraná (schist) | 3,813 | --- | 3,813 | 128 | --- | 128 | 4,616 |
| São Paulo | --- | 6,169 | 6,169 | --- | 886 | 886 | 11,741 |
| Total Brazil | 211,858 | 1,781,905 | 1,993,763 | 15,259 | 34,874 | 50,134 | 2,309,095 |
| Africa | --- | 57,444 | 57,444 | --- | --- | --- | 57,444 |
| North America | --- | 2,162 | 2,162 | --- | 386 | 386 | 4,431 |
| South America (Consolidated) | 82,792 | --- | 82,792 | 16,013 | --- | 16,013 | 177,045 |
| South America (non-consolidated) | 7,214 | --- | 7,214 | 131 | --- | 131 | 7,988 |
| Total abroad | 90,007 | 59,605 | 149,612 | 16,145 | 386 | 16,530 | 246,907 |
| Total Petrobras | 301,865 | 1,841,510 | 2,143,375 | 31,404 | 35,260 | 66,664 | 2,556,002 |

**Notes:**
* Consolidated Production is the production coming from companies controlled by Petrobras.

** Non-consolidated production is the production that comes from companies in which Petrobras holds stakes, but not control.

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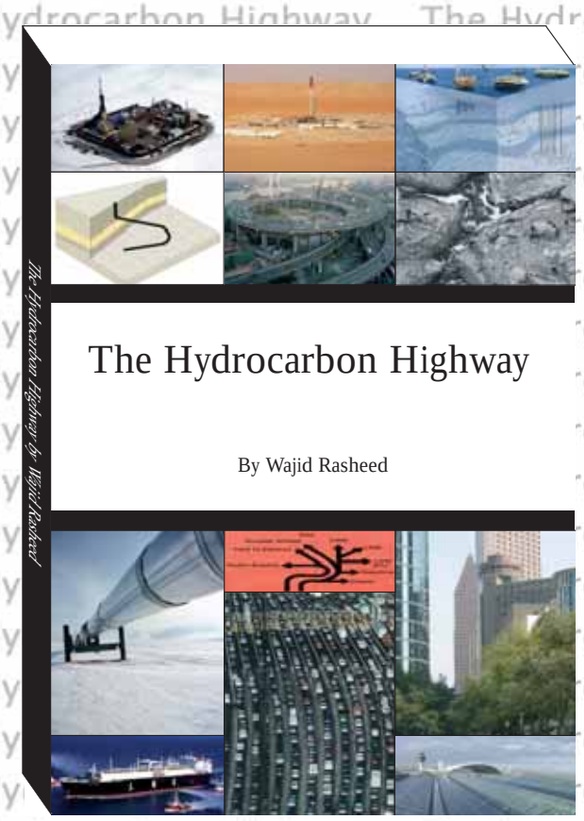


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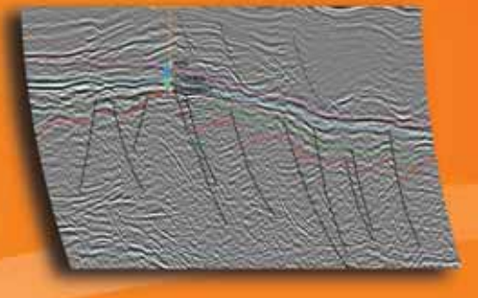

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