LNG Market Integration from the Asian Perspective

By Ryo Fukushima

This is the third of the case studies by the Task Force looking at Gas Market Integration to be presented in this issue of the IGU Magazine.

Launched in 1964, the international commercial LNG trade was a new method of transporting natural gas over long distances. Since then it has expanded dramatically with regions such as Europe using LNG to supplement pipeline gas, while countries in north-east Asia with scarce natural gas resources rely on LNG for the bulk of their gas supplies.

North-east Asian LNG imports started in 1969, and by the end of the 20th century, 72% of global LNG production was flowing into this area. Meanwhile, Indonesia, Malaysia, Brunei and Australia in the wider Asia-Pacific region had become important producers, accounting for 55% of global LNG production.

According to the 2009 BP Statistical Review of World Energy, global LNG production in 2008 was 168 million tonnes. However Indonesian LNG production has been declining while that from the Middle East and North Africa has been increasing. The latter regions produced more than 50% of the world's LNG whereas Asia-Pacific's share fell to 38%. In terms of demand, new Asian countries have entered the market with India starting LNG imports in 2004 and China in 2006. Asia-Pacific including southern Asia consumed 69% of the world's LNG in 2008 and the region is expected to continue to increase its LNG consumption by adding new LNG import countries.

Normally LNG contracts are negotiated on a long-term basis, but there are some spot LNG cargoes and the number of such cargoes diverted from one market to another to meet surges in demand has increased. This trend has added linkages between regional gas markets which may result in the development of a true global natural gas market.

This paper will reconfirm the characteristics of the LNG trade by reviewing LNG market development – mainly in Asia – and will highlight the core feature of LNG, which is a bilateral dependence between the seller and the buyers, even in the context of globally traded LNG volumes.

Development of the Asian LNG market

Japan

Only five years after the world's commercial LNG trading started, Japanese utilities Tokyo Electric Power and Tokyo Gas began to purchase LNG from Alaska in 1969. This was the first LNG trade in Asia and was driven by environmental and supply diversification issues. Japan had almost no indigenous natural gas resources and relied on oil and coal. Adding cleaner natural gas to the energy mix was a way to reduce air pollution and diversify the energy sources for electricity generation and feedstock for city gas.

As regards the city gas sector, the changeover from manufactured to natural gas was done gradually due to the need to cater for millions of existing residential and industrial consumers. It took 16 years for Tokyo Gas to switch and 15 years for Osaka Gas, which started the LNG fuel switch in 1975.

In the electricity generation sector, Tokyo Electric constructed the world's first dedicated LNG-fuelled power plant adjacent to the LNG receiving terminal in Negishi, Yokohama to meet increasing demand for electricity in line with Japan's rapid economic growth.

In the 1970s, because of the fear of oil supply disruption and oil price increases caused by the oil crisis, power companies accelerated their shift from oil-fired to natural gas-fired thermal plants, while the shift from oil to natural gas as the feedstock for city gas was also stepped up. Demand for natural gas in Japan increased but, as the

Asia-Pacific's first LNG cargo was delivered by the 71,500 m^3 *Polar Alaska*, which operated a shuttle service between Kenai and Yokohama with its sister ship *Arctic Tokyo*.

utility companies were independent and privately-owned, the tendency was for each company to build an LNG receiving terminal rather than to participate in developing an inter-connected pipeline transmission network.

Japan imported around 68 million tonnes of LNG in 2008 – approximately 40% of world LNG trade – through 27 receiving terminals. There are also two small LNG terminals that receive secondary transport deliveries by small LNG coastal tankers.

As will be discussed below, on the one hand, LNG projects require a guaranteed level of demand, and on the other hand, LNG purchasers such as city gas companies like to have import flexibility to meet demand fluctuations. In order to aggregate the volume and absorb the fluctuations internally, a consortium was formed and went into LNG purchase negotiations.

From the 1970s to the 1990s, Abu Dhabi in the UAE, Brunei, Indonesia, Malaysia and Australia became LNG suppliers to Japan; most LNG was supplied from south-east Asia and Oceania. The large-scale supply of LNG from Qatar to Japan started much later, in 1997.

Korea and Taiwan

In order to introduce natural gas and LNG into the country, South Korea established a state-owned company called Korea Gas Corporation (KOGAS) in 1983. KOGAS became the sole supplier to existing and new city gas companies and to the Korean Electricity Power Corporation (KEPCO). KOGAS was given a monopoly to import LNG in parallel with the construction of the country's trunk line infrastructure. In 1986, its first LNG shipment arrived from Indonesia.

South Korea has a high demand for natural gas especially in winter because of the widespread use of district heating and home floor heating. Meanwhile, LNG delivery from the LNG production facility is essentially a constant throughout the year. In order to achieve higher supply in winter, KOGAS has not only increased the number of LNG storage tanks but also asked KEPCO to take

Korea has four LNG receiving terminals – this is Incheon which is operated by KOGAS – and plans to build a fifth by 2013.

more gas in summer. Moreover, greater consumption of gas in summer is promoted through uses such as district cooling to equalise LNG reception.

As a result of South Korea's economic crisis in 1997, KOGAS was lined up for privatisation in 1999 and the government planned to separate it into LNG import and gas transport divisions. At the same time, LNG import liberalisation and third party access to the LNG terminal and trunk line infrastructure were also considered. However, due to changes in economic circumstances, only one private LNG import terminal was built by K-Power (a joint venture of SK and BP) and Posco (a steel mill company) for their own consumption needs.

Currently, South Korea has three LNG receiving terminals operated by KOGAS in Incheon, Pyeongtaek and Tongyeong, and one by SK/Posco in Kwangyang. KOGAS's three terminals have 40 LNG receiving tanks in total. Indeed, a typical feature of LNG receiving terminals in north-east Asia is the greater number of storage tanks compared to terminals in other parts of the world.

BELOW
China's Guangdong Dapeng LNG terminal started operations in 2006.

Taiwan started LNG imports in 1990 through a terminal operated by CPC Corporation in Kaohsiung, and has steadily developed its gas infrastructure. A second receiving terminal is under construction at Taichung. LNG accounts for 96% of Taiwan's gas supply and 75% of the total gas consumption is used for power generation.

China

Over many years China has developed a domestic natural gas infrastructure. These efforts have been intensified in order to support the rapidly growing economy and to reduce pollution from the extensive use of coal. Domestic production is being increased and LNG imports have been started.

Completed in 2004, the West-East Gas Pipeline (western gas supply to eastern demand) runs for 4,000 kilometres connecting the gas fields of the Tarim Basin in north-west China and those of the Ordos Basin in central China with Shanghai on the east coast. This trunk line gas had to compete with cheaper local gas and coal as fuel sources for power plants. Before construction started, a gas price of $5.00/mmbtu was assumed and this price raised many questions regarding the profitability of the project. However, the rate of growth in demand is far more than expected and a second pipeline is being constructed.

As for the LNG receiving terminals, Guangdong LNG received its first cargo in May 2006, followed by Fujian LNG in August 2009, while Shanghai's receiving terminal is expected to start operations by the end of 2009. China's LNG contract price is linked to Japan's oil import prices as well as other north-east Asian buyers, although the price formula has both a floor and a ceiling. In 2007 and 2008, when China bought spot cargoes from Nigeria and other African exporters, it was able to combine these higher-priced cargoes with the cheaper long-term contract cargoes to give an affordable average cost.

● History – I: Beginning of the LNG trade

Investment in buyer's facilities

When planning to introduce LNG, as shown by the examples in Asia, the construction or expansion of the receiving terminals has to be carried out in parallel with negotiations with the LNG producers. Realising a project to build a receiving terminal takes many years with the need to carry out environmental impact studies, obtain the necessary permits, raise the finance and then construct the facility.

Also, unlike US or European LNG terminals, because there is less supporting infrastructure in terms of high-pressure trunk lines and underground storage facilities to absorb re-gasified gas, more LNG storage tanks are needed. If there is no such margin of LNG tank storage, much greater effort is needed in terms of demand control and delivery timing, which requires the cooperation not only of sellers but also of other buyers.

A fuel switch to natural gas is usually associated with a large amount of capital investment by consumers such as the replacement of installed gas appliances in each household, and the construction of high efficiency gas-fired power plants to replace older power plants.

Launching LNG plants

At each new LNG liquefaction plant, in order to maximise the use of the facilities including tank storages and shipping facilities, it used to be said that at least 3 to 6 million tonnes of production capacity was required. Because of this restriction, a relatively large gas field (around 10 tcf/280 bcm) was necessary. Moreover, the construction of a liquefaction plant demands a five-year lead time and large-scale investment.

Ship construction

In the early stages of LNG projects, LNG ships were dedicated for each project, and the contract mainly used to be ex-ship or delivered ex-ship (DES) where the seller prepares, ships and delivers LNG to the buyer's facility. Clearly, as the scale of the project increases, more ships and greater investment become necessary for the seller. It is the same for buyers if the project is on a free on board (FOB) basis, as buyers have to invest more money for ships to transport LNG from the seller's terminal.

Necessity of long-term contracts

Given the major investment needed by both buyers and sellers to commence an LNG project, buyers have to scrutinise the balance of supply and demand and the prices to customers, while sellers have to continuously search for other buyers, carry out their evaluations to reach a final investment decision (FID) and secure the financing to construct. After all of the efforts are made, a 20-year contract will be entered into to secure the investment for both sides.

LNG negotiations

Negotiations involve not only price but also a project's start-up timing, the quantity and flexibility of deliveries, the LNG quality such as heating value, the size of the ship used for transport and destinations of cargoes. Due to the range of issues discussed, traditional Asian LNG contract negotiations took a few years until the FID was made. Project construction typically took a further five years.

Thus LNG projects in this era – like pipeline projects – were based on a long-term relationship between the seller and the buyer. Also in the same manner as pipeline projects, the buyer had to commit to take a fixed volume annually in order to secure the financing of the project and had less flexibility to decrease the volume under the so-called "downward quantity tolerance" or "take or pay" clauses. The upward flexibility was also low and this could only happen when there was a production surplus.

● History – II: Market progress in the 21st century

Soon after the 21st century began, and as the existing Asian LNG market grew, buyers sought to increase the flexibility of their LNG contracts. For example, the power companies wanted a flexible volume to provide back-up in cases of emergency such as problems with nuclear power plants, while gas utilities wanted flexibility to cater for demand fluctuations caused by weather conditions or by structural changes in industrial sectors.

KOGAS, which has a winter demand peak, invited international tenders to obtain a satisfactory pattern of LNG deliveries concentrated in the winter. In parallel, new LNG market players such as China and India decided on their LNG imports, which made the Asian LNG market more active.

China into the market – downstream

In 2002, China made two large LNG deals and, in parallel, participated in upstream LNG developments both to utilise its plentiful foreign currency

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India started LNG imports through the Hazira terminal in April 2004.

reserves and to secure natural resources in various countries. CNOOC's Guangdong LNG project contracted with the North West Shelf project in Australia, while CNOOC's Fujian LNG project contracted with Indonesia's Tangguh project. The contracts introduced a floor-ceiling clause that was not used in the traditional markets of Japan, South Korea and Taiwan. This meant that while at lower oil prices China's LNG price was higher than existing market prices, for most of the oil price range its LNG price was cheaper, leading to the so-called "Guangdong Shock". The existing buyers, who believed they had contributed to the North West Shelf LNG project with the sellers, raised concerns with the sellers about their long-term relationship.

Sakhalin II – new style upstream

During the same period, a number of upstream projects were under development, and that with the largest impact on the Asian region was Sakhalin II with a production capacity of 9.8 mtpa. The Sakhalin region in Russia is considered to have abundant gas resources – almost equivalent to those of the North Sea – but had not been developed for a long period for geopolitical reasons.

Sakhalin II started exports in March 2009 and one of the reasons the project was realised is that it has many types of customers with contracts tailored to each buyer's requirements. Thus the seller has responded to the requests of each buyer with their different expectations regarding procurement of LNG.

Dash for LNG in the world

In addition to the new LNG markets developing in Asia, the United States moved to increase LNG imports with proposals for many new receiving terminals. Thus, LNG markets in both the Atlantic and Pacific Basins saw simultaneous activity.

Qatar was quick to respond, being equidistant from the three important markets of Asia, Europe and the US, and adopted the strategy of becoming a swing supplier to those markets. Drawing on the world's third largest gas reserves, Qatar invested heavily in large LNG trains and tankers in order to reduce costs to ensure competitiveness.

A new form of LNG marketing has emerged, and the long-awaited Gorgon project is an example. Its equity owners are Chevron, Shell and ExxonMobil, with each company having different marketing views. In 2005, Chevron reached a memorandum of understanding with Japanese utilities such as Tokyo Gas, Osaka Gas and Chubu Electric. For its part, Shell entered into a sale and purchase agreement with PetroChina, while ExxonMobil will sell to Petronet of India. The Gorgon project allows each equity holder to market up to their respective share of total production capacity. This is so-called equity marketing and allows each seller to be more flexible in marketing.

● Changes in the supply and demand balance

Downstream changes

In recent years overall LNG demand has been growing, driven by a combination of environmental issues and the needs of emerging economies such as China and India, while the trade's volatility has increased.

Through partnership comes progress.

In Japan, for example, nuclear power plants have faced major long-term inspections and repairs since 2005, while an earthquake in 2007 in Kashiwazaki north of Tokyo damaged the local nuclear power plant. Consequently, a large share of nuclear generating capacity was lost and even now Japan's capacity is down 7GW. To make up the shortfall, LNG or oil-fired power plants are the main alternatives, and LNG demand has temporarily increased. Nuclear power plants are gradually returning to service but the short-term additional demand for LNG continues.

Supply side changes

Since the beginning of the 21st century, LNG demand in the Asia-Pacific region has increased while new sources of LNG supply have been limited to Malaysia LNG 3 (2003), the North West Shelf expansion (Train 4 in 2004, Train 5 in 2008), RasGas 2 (Train 3 in 2004, Train 4 in 2005, Train 5 in 2007) and Darwin (2006).

In December 2005, the Indonesian government announced that the domestic gas supply for fertiliser plants should be given priority over LNG supply from the Arun LNG project. Its nominal capacity of LNG liquefaction is 8.4 mtpa; however, only 6.5 million tonnes of LNG was shipped from the terminal.

Also in 2005 at Indonesia's Bontang LNG plant, a minor plant shutdown damaged the production gas well and the production rate has not recovered since then. Many of the buyers from the project were forced to reduce the quantity to be delivered. In addition at the same time in the Bontang area, the government again decided to give priority for gas usage to a local fertiliser plant. Thus Japanese buyers, who were negotiating the renewal of the contract from 2011, were forced to reduce the new contract volume to only 3 mtpa compared to the current contract volume of 12 mtpa. Similar requests for volume reduction were made to other buyers such as KOGAS and CPC.

As a result, a gap between supply and demand in the Asian region emerged and in order to fill the gap, Asian countries including China and India imported 20 million tonnes of short-term LNG mainly from Africa (Egypt, Algeria, Nigeria, etc.) and the Middle East (Qatar, Oman).

● LNG market integration

Market integration from gas price indexation

The price of natural gas is usually indexed against the price of the fuel in competition with natural gas. However, the US gas price is basically a domestic gas market price, and imported gas is also linked to the domestic gas price. It is mainly used for electricity generation and to supply city gas networks.

On the supply side, due to the decline of both conventional domestic gas production and imports from Canada, it used to be said that an increase of LNG imports should be considered immediately. However, while construction of LNG receiving terminals went ahead, LNG import contract negotiations did not make progress at all. Thus LNG imports did not grow as much as expected.

Meanwhile, production from unconventional gas resources such as coal-bed methane and shale gas and from deep water offshore wells in the Gulf of Mexico has increased. Accordingly, the US LNG price will still be linked to the domestic gas price and will have a weak linkage with other fuels such as oil.

The Netherlands and the UK operate virtual gas trading hubs called the Title Transfer Facility (TTF) and National Balancing Point (NBP) respectively, and the LNG price is indexed to the market price. In other European countries where coal and oil are alternative fuels, the gas price is indexed by a basket formula of them. Historically in most of Europe, the gas price has often been linked to oil. Natural gas is imported mainly via pipelines from Russia and countries in Africa facing the Mediterranean Sea, but also as LNG from northern and western Africa. In recent years, Russian pipe-

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Consolidated Production 2008

Natural gas	30.9 bcm (1.1 tcf)
Crude oil and gas condensate	2.6 mmt (21.4 mmbbl)
Total gross production	223 mmboe

Reserve Base as of 31 December 2008

Natural gas (proved, SEC)	690 bcm (24.4 tcf)
Natural gas (proved+probable, PRMS)	1,017 bcm (35.9 tcf)
Total reserves (proved, SEC)	4,963 mmboe
Total reserves (proved+probable, PRMS)	7,498 mmboe
2008 Reserve Replacement Rate	230%
Reserve–to–production life	23 years

China is a major oil and gas producer but other countries in north-east Asia lack significant petroleum resources.

line gas supplies, which account for about one quarter of European gas demand, have suffered disruption as a result of disputes with transit countries and European countries are looking to diversify their sources.

Most of the LNG prices in Asia, as previously noted, are linked to Japanese oil import prices for the historical reason that LNG was introduced as an alternative fuel for oil. Moreover, except for China, the north-east Asian region does not have significant natural gas resources. Since there is no back-up pipeline supply of gas, Asia generally has had to endure a higher LNG price than other markets, the so-called Asian premium. In recent years, due to rising oil prices, in Asia as well as Europe, LNG prices have been increasingly linked to oil and the price gap between the two markets has lessened.

From the above it can be seen that, at the time of writing, the US gas market price is independent from those of other areas, as it faces gas-to-gas market competition with some adjustments in peak periods due to dual fuel consumers. Because of the price differences between the markets, only the LNG committed to long-term is brought inside or outside the US market, and the cargoes which were supposed to be destined for the US are diverted to Europe and north-east Asia and vice versa.

Market integration from LNG quality

LNG quality, particularly in terms of the expected heating value, is different between the markets and care is needed. From the production side, due to the differences of feedstock gas for LNG and the differing characteristics of liquefaction plants, the heating value of LNG varies from project to project.

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LNG from Alaska, the first LNG source for Japan, has a low calorific value and is rich in methane, but later projects supply high-heat content. The city gas companies in Japan add LPG to the re-gasified gas to maintain the stable heating value of city gas even though the composition of the source LNG is different. For this historical reason, in most of the north-eastern Asian LNG import countries, gas facilities are designed to receive this high heating value natural gas.

In the United States, traditionally and because of the emergence of coal-bed methane gas in recent years, generally low-calorie gas is traded. Thus some American LNG receiving terminals are equipped with facilities such as LPG extraction or nitrogen injection to enable them to receive high-calorie LNG.

In Europe, the natural gas heating value largely differs by production area and in some cases special measures, such as installing two trunk pipelines for different heating values, are necessary. Roughly speaking, the expected heat value in Europe is in the mid-range of the Asian and US values.

Each of these markets has a different expectation level of heating value. When launching an LNG project, the project side usually designs the facility for a particular market and then long-term contracts will normally be concluded. For example, Qatargas 1 was designed to supply LNG with a high heat value to the Japanese market, while Qatargas 2 extracts more LPG during the liquefaction process to suit the UK and US markets.

When considering the switching of LNG cargoes between markets, therefore, marketing considerations enter the equation such as whether the buyer or the receiving terminal has facilities to adjust the heating value.

Players among the markets

Potential players who can move LNG between markets are either sellers or buyers who have the facilities and the flexibility to trade. One example is the company which does not sell all its marketing volume under long-term contracts and uses the balance to cater for spot trades. Of course that business model has the potential risk that if the market becomes weaker, players have to endure the accumulation of unsold volume or sell at a lower price. Such a risk taker might be an existing seller with an established market position and in the stage of expansion.

Another example is the case where the seller and the buyer cooperatively create the flexibility to supply another market. In Europe, for example, contracts allow LNG supplies to be diverted and alternative pipeline supplies are available.

LNG is likely to continue to be diverted between the markets where a price gap exists.

● Conclusion – necessity for sustainability

As LNG production capacity increases, the scope for flexibility in trading increases. The flexible volume will be that remaining after the long-term contract needs have been fulfilled and will be used to stabilise demand-supply gaps in regional gas markets. In order to make this happen, technical factors need to be considered such as higher operational safety, the compatibility of heating values, adequate storage, ship compatibility and flexible delivery. But addressing these factors should not interfere with the base long-term contracts.

There is also an important market consideration. A stable trading environment, mutual long-term relationships between sellers and buyers, and stability and predictability of political systems are required. Especially in Asia, as the number of LNG players increases, mutual cooperation and regular information exchange among the players become more important and deepen the understanding of market characteristics.

Natural gas and other energy resources are public goods necessary for human life; people in this business should always bear in mind the importance of maintaining market stability. Moreover, both sellers and buyers – be they trading in LNG

or pipeline gas – have made large initial investments in their own facilities and in setting up gas transit flows which connect the producers and consumers directly or indirectly. Sellers and buyers make each LNG project sustainable by meeting each other, getting to know each other and protecting each other with a long-term and stable contract. New entrants to the market as buyers should not disturb the existing market balance of supply and demand, but rather support the launch of new projects.

Unlike pipeline gas, LNG has destination flexibility; however, LNG cannot be stored long term (as oil can), and LNG trading depends on the compatibility of facilities (including ship size), LNG quality and timing of reception based on LNG tank inventory. Bearing in mind these characteristics, a healthy LNG market will result if the players, both sellers and buyers, aspire to long-term stability and cooperate to accommodate LNG requirements (including in other markets) to fill their demand and supply gaps.

Both sellers and buyers should recognise that LNG projects involve capital investments with risks on both sides, and, as LNG projects are commercial, each side has to do their utmost to fulfil the contract. If any issue arises which affects the stability of supply, it is important for both parties to resolve the issue in good faith.

The roles of governments or policy-makers are primarily to support the development of projects – both upstream and downstream – whose start-up periods are weak in terms of financing. During the operational period, their roles are to maintain the predictability of the business environment by offering stable policies.

This paper was prepared for IGU's Gas Market Integration Task Force by Ryo Fukushima who is a Task Force member and the General Manager of Business Development Division II, Tokyo LNG Tanker Co. Ltd.

Qatargas 1 was designed to supply LNG with a high heat value to the Japanese market.

Brazil's Natural Gas Industry Faces a Great Challenge

In the strive for energy autonomy which ensures development, Brazil will expand its gas pipeline network over 50% in the next three years and is diversifying its natural gas supply sources with the introduction of LNG in the domestic market. ANP — the National Agency of Petroleum, Natural Gas and Biofuels — participates in these developments by issuing new regulations for the construction and operation of facilities, supply, storage and regasification of LNG, as well as authorising the construction and operation of new gas pipelines. Thus, the Agency fulfils its role to regulate in the interest of the domestic supply and the Brazilian consumers.

Oil & gas sector growth

ANP was established on January 14, 1998 as a fundamental part of the new model for the oil and natural gas sector in Brazil, which was set out by the Oil Law of 1997. In these 11 years, the Agency responsible for the regulation of the industry activities was crucial for the broadening of the Brazilian's geological knowledge, to ensure market supplies and to improve the quality of the fuels sold in the country.

- Since ANP's creation, the oil and natural gas industry has grown over 300% and its participation in Brazilian GDP has leaped from 2.75% to over 10%.
- As a result of the bidding rounds of exploitation areas made by ANP, today over 80 economic groups (half from Brazil and half from other countries) are active in the country's exploration and production (E&P) sector.
- The commitments made by these groups to ANP, apart from investments in pre-salt layers, add up to a minimum of US$55.75 billion to be invested in E&P over the 2009-2013 period. With E&P in pre-salt layers, these investments may surpass US$100 billion.
- The geological and geophysical studies allowed and promoted by the Agency and the exploitation activity of the concessionary companies have widened Brazilian oil potential knowledge considerably. Brazil is today among the countries with the highest level of seismic data acquisition.
- Underway since 2007, the Multi-annual Plan for Geology and Geophysics Studies (PPA) predicts an investment of around R$1 billion before 2011, in data acquisition in 24 onshore sedimentary basins that have been subject to little or no research.
- National proved oil reserves leaped from 7.1 billion barrels at the end of 1997 to 12.8 billion barrels by the end of 2008, while those of natural gas increased from 227.7 bcm to 364.9 bcm in the same period.
- The quality of discoveries has also improved, with the emergence of light oil accumulations of higher added value, especially in the Santos and Espírito Santo basins. Recently, Brazil has celebrated the discovery of oil in pre-salt layers in the Campos and Santos basins.
- In 11 years, Brazilian oil production has grown from around 870,000 b/d at the beginning of 1998 to around 1.9 million b/d in 2008. And it could reach 2.5 b/d before 2015.
- In the same period, gross natural gas production has almost doubled, going from 26.9 mcm/d to 59 mcm/d, with expectations of reaching 100 mcm/d in 2013. Preliminary data indicate that the natural gas market (Petrobras's domestic production plus imports) was 69 mcm/d in 2008.
- Natural gas has ceased to be a marginal energy source, increasing its share in the national energy matrix from 3.67% to 9.3%. The Brazilian consumer market has respectable proportions.
- The apparent oil consumption (sum of the production, liquid importation of oil and the liquid importation of derivatives) has reached 304,000 cm/d or 1.912 million b/d in 2008. In 2008, 92.7 mcm of oil derivatives were sold in the Brazilian market.
- Biodiesel, that was nonexistent a decade ago, nowadays is present in at least 4% of the total amount of diesel marketed in the country.

Brazilian gas and LNG market

Despite the improvements, Brazil faces the huge challenge of reducing its dependence on imported products. Around 33% of natural gas in the Brazilian market is consumed by industry in the south-east. The Brazilian electricity sector (mainly hydroelectric, thus subject to weather conditions) relies on gas-powered thermoelectric plants to balance supply to the integrated electrical system in the case of low water levels in the power plants. (In 2007, 14% of the available gas in Brazil was consumed for this purpose, according to the National Energy Balance 2008, base-year 2007.)

The challenge is being faced in two main ways: by increasing Brazilian production and the pipeline network and the introduction of LNG.

The government target is to meet the forecast national demand for natural gas in 2012 of 134 mcm/d, which means trebling the supply of natural gas. Of this projected total, 73 mcm/d (54.5%) should be from Brazilian production, 31 mcm/d (23.1%) as LNG (imported from Trinidad or countries in Africa) and 30 mcm/d (22.4%) from Bolivia.

The efforts developed by ANP are essential for the attainment of these goals, since it is the Agency that authorises the projects and pipeline construction (without which the plans cannot be carried out), and prepares the new regulations about the operational security of gas pipelines, methodology to calculate third-party access tariffs and standardisation of agreements. Also noteworthy is the ongoing development by the Agency of a training programme for technicians to regulate, monitor authorise LNG installations, technology until now not used in Brazil.

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Brazil grows and the oil & gas sector is strategic in this movement. In this strive for energetic autonomy which ensures development, the country will widen its gas pipeline network in over 50% in the next three years and is diversifying the natural gas supply sources, with the introduction of Liquefied Natural Gas (LNG) in the domestic market. The ANP - National Agency of Petroleum, Natural Gas and Biofuels - participates in this change by issuing new regulations for the construction and operation of facilities, supply, storage and regasification of LNG, as well as authorizing the construction and operation of new gas pipelines. Therefore, the ANP fulfils its role to regulate in the interest of the domestic supply and the Brazilian consumers.

anp
National Agency of Petroleum, Natural Gas and Biofuels

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BRASIL
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Developments on the GTL Front

By Mark Blacklock

The gas-to-liquids (GTL) sector is seeing some interesting developments with Uzbekistan the latest country to evaluate a project, Qatar Airways planning the first flight test of an airliner wholly fuelled by a GTL blend and Japan trialling a new development on the process front. Meanwhile, construction of the world's largest GTL plant is well underway with the first production expected in 2011.

Qatar

Qatar has become a major player in the GTL business by building on its gas resources and infrastructure, and developing international partnerships to access Fischer-Tropsch technology.

The industrial city of Ras Laffan, home to the world's largest complex of LNG trains, is also the base for GTL production, while there is a research centre in Doha's Science and Technology Park.

Qatar Petroleum's partners for the GTL plants in Ras Laffan are Sasol and Royal Dutch Shell, with the Oryx joint venture using Sasol's low-temperature slurry phase distillate (SPD) process and Pearl using the Shell middle distillate synthesis (SMDS) process. The research centre is run by Shell.

As reported previously in the IGU Magazine, Oryx faced problems in ramping up to its 34,000 b/d design capacity but these have now been resolved. The plant's Technical Manager, Riaan Welgemoed, told delegates at the Ninth World XTL Summit organised by CWC in May that while production in 2008 totalled 6 million barrels, for the first quarter of 2009 it was up to 2 million. "The focus is on further improvement of plant reliability and optimisation," he said.

Work is well underway on Pearl GTL which represents an investment of over $20 billion.

Oryx is supplying diesel to customers in the Gulf and Europe and naptha to Asia; and Welgemoed described profit margins as "healthy, even at current oil prices", pointing out that more stringent global fuel specifications will drive demand for GTL diesel. "We are eagerly awaiting the successful commissioning and start up of Pearl GTL," he added. "We believe we need to work together to develop the market and realise GTL's potential."

Pearl is an integrated upstream and downstream project that will produce 44.8 mcm (1.6 bcf) per day of wellhead gas from the North Field for processing to extract around 120,000 b/d of condensate, LPG and ethane, and supply dry gas to two 70,000 b/d GTL trains. Some 40,000 workers are now on site and construction is due for completion at the end of 2010, with commissioning of Train 1 in 2011 followed by Train 2 in 2012. The GTL products slate will comprise naptha, normal paraffins, kerosene, diesel and base oils.

Speaking at the XTL Summit, Shell Gas and Power's Vice President for XTL Development, Guy de Kort, described Pearl as a second generation GTL plant, SMDS having first been introduced at the 14,700 b/d Bintulu plant in Malaysia. "Bintulu has been crucial for innovation in Pearl GTL," he said, highlighting catalyst improvements. Indeed, Shell Gas and Power won the CWC World XTL Award 2009, which was presented during the Summit.

Meanwhile, Qatar Airways is preparing for a commercial flight fuelled wholly by a 50:50 blend of GTL kerosene from Bintulu and normal jet fuel. (An initial trial in February 2008 involved an Airbus test aircraft with one of the A380's four engines fuelled by a 40:60 GTL blend.) The pioneering trial will be carried out by the end of the year, probably on the Doha-London route, and there will also be a control flight using 100% standard jet fuel. The airline is hoping to show that using the GTL blend will result in a reduced fuel burn.

Qatar Airways is preparing for a commercial flight fuelled wholly by a GTL blend.

Nigeria and Uzbekistan

In addition to its Qatari partnership, Sasol has teamed up with the Nigerian National Petroleum Company (NNPC) and Chevron to develop Escravos GTL, which is drawing on the Oryx experience as it too has a 34,000 b/d capacity and uses the SPD process. "We have been working very closely with the Escravos team to transfer the lessons," said Welgemoed.

However, commissioning of Escravos is not now expected until 2012 as the global surge in engineering, procurement and construction (EPC) costs combined with the difficulties of working on the site 100 kilometres southeast of Lagos meant that the EPC had to be renegotiated from a lump-sum to a reimbursable contract. Whereas Oryx was delivered for just under $1 billion, Escravos is costing $6 billion. According to Chevron, which will operate Escravos, the biggest milestone achieved in 2008 was the installation of two reactors, and this year will see the shipping and positioning on site of the remaining process modules.

Sasol is also involved in the latest GTL project in Uzbekistan. "The wealth of gas resources within Uzbekistan makes this an ideal location for a GTL facility," said Sasol Group General Manager Lean Strauss, whose partners in Uzbek GTL are Petronas and Uzbekneftegaz. The proposal is for a 40,000 b/d plant using SPD and negotiations are underway with the Uzbek government on the detailed

A delivery of components to the Escravos GTL site.

requirements for proceeding to the next phase of project implementation, including the establishment of a joint-venture company.

Japan

On the technology front a Japanese consortium called Nippon GTL Technology Research Association has developed the Japan GTL process, which uses carbon dioxide instead of oxygen in the production of syngas, and is trialling this at a 500 b/d demonstration plant in Niigata. The advantage of the new process is that feedstock with a CO_2 content of up to 20% can be used, thus removing the need for treatment or, in the case of stranded gas where treatment would not be viable, allowing it to be monetised.

This plant in Niigata started up in April to test and verify the Japan GTL process.

South Africa

Finally in South Africa, Petro SA's pioneering GTL plant at Mossel Bay is facing a feedstock crunch. Domestic gas production will tail off in 2010 so plans are in hand to import up to 1.5 mtpa of LNG as a feedstock. The LNG will be fed into the existing gas supply system via an offshore facility using floating storage and regasification vessels. Although expensive, importing LNG is better than closing the plant and is viewed as a bridging solution until new domestic gas sources can be developed.

Mark Blacklock is the Editor-in-Chief of International Systems and Communications.

The National Hydrocarbons Corporation of Cameroon

Promoting the development of national gas resources

Major projects

Project to construct a gas to power plant at Kribi

The project comprises two components:

- Gas component
  - Development and exploitation of Sanaga Sud gas field;
  - Construction of a gas processing facility;
  - Construction of a gas pipeline between the central processing facility and the gas fired power plant.
- Electric component
  - Construction of a 216 MW plant;
  - Construction of a 225 KV transport line from Kribi to Edea,

The power station is expected to be commissioned in 2011.

Project to construct a gas liquefaction plant in Cameroon

- It aims to develop a Liquefied Natural Gas (LNG) unit in Cameroon, with a capacity between 1.5 and 3.5 million tons a year;
- The project will be based in the Kribi or Limbe area;
- SNH and GDF SUEZ entered into a Memorandum of Understanding in November 2008 to study the feasibility of the project.

Project to Construct LPG storage installations

- There are plans to construct LPG reception and storage tanks in Kribi, Douala, Yaoundé, Ngaoundéré and Maroua;
- SNH and CSPH have signed a memorandum of understanding to carry out studies toward the construction of the tanks;
- An invitation to tender was launched in April 2008 for the realisation of feasibility studies to construct two 2 x 4000 m^3 tanks in Kribi.

The tanks are expected to be commissioned in 2012.

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Libya's Natural Gas Potential

By new IGU Charter Member National Oil Corporation of Libya

HE Dr Shokri Ghanem, Chairman of National Oil Corporation of Libya.

Dr Omar Abdelkarim, Member of the Management Committee of NOC.

Libya, with proven natural gas reserves of 52 tcf (1.5 tcm), has significant gas potential. So far, the country's gas resources have been largely unexploited and unexplored; it is believed that gas reserves might exceed 100 tcf. The most prolific discovered gas reserves are located in the Sirte, Ghademes and Murzuq Basins and North Western offshore blocks. Eni-Gas (Mellitah Oil & Gas), Sirte Oil, Waha and AGOCO are the major companies operating in the sector with more than 35 tcf of gas reserves.

Until recently, crude oil was the focus of hydrocarbon exploration and exploitation. However, with the increase in demand for natural gas from domestic and international consumers, particularly from European markets, National Oil Corporation (NOC) of Libya has adapted a National Energy Strategy to develop discovered gas fields in order to expand the gas production capacity of the country. As a part of this strategy, NOC has opened several new blocks and invited international operating companies to form close partnerships for the exploration and exploitation of oil and gas resources together. The latest oil, condensate and gas discoveries in the new concessions of Ghademes Basin by Verenex, AGOCO and Sirte Oil are substantial. A recent gas discovery by Amerada Hess in their offshore concession is under appraisal; reserves in a thick carbonate reservoir are estimated as substantial.

As of 2004, Sirte Oil Company was the only Libyan natural gas producer from the Sirte Basin fields: Attahadi, Hatiba, Sahl and Assumud. Most of the production was utilised for petrochemical products and to supply the LNG plant in Marsa El Brega, with some for local consumers.

Now Libya wants to use natural gas instead of oil – particularly for power generation and other ever increasing local energy requirements – freeing up more oil for export. Libya is also working to increase gas exports. In this respect, as a part of an international joint venture with Eni of Italy, the first West Libyan Gas Pipeline Project was completed in 2004 and gas exports through the 32-in pipeline, beneath the Mediterranean Sea to Europe, commenced in the same year. The gas export capacity of this pipeline has been backed up from the onshore Wafa field and offshore blocks, and increased to 8 bcm per year in 2008. Development of the other discovered offshore blocks in Concession 41 is at the planning stage to further back up this pipeline.

As a part of the development of the country's gas infrastructure, the coastal pipeline system, feeding the various industries in the country, is being extended to the west to meet local demands and connect with international export outlets. Additionally, NOC plans to build a complete gas pipeline network linking the country's gas resources to gather all associated and non-associated gas. Currently some major gas development and gas utilisation projects for associated and non-associated gas potentials are underway in the Sirte and Ghademes Basins.

Libya is also working on its LNG export options and NOC is currently planning to rejuvenate the existing LNG plant at Marsa El Brega and develop a new one.

Libya has significant gas potential.

The Wafa gas treatment plant.

Natural Gas in Kuwait

The importance of natural gas to the State of Kuwait was evident in the years spent on exploring for a local source. Kuwait was traditionally known as "Black Oil" country and it was only with the recent major find of free natural gas in North Kuwait, in 2000, that the country became a player in the gas area. The find, due primarily to the results of seismic surveys, emphasized the importance of state-of-the-art technology.

Natural gas was subsequently produced at a Production Facility in 2008. Currently producing 175 mcfpd, plans are underway to increase production at the facility to 600 mcfpd by 2011 and 1 bcfpd by 2015.

Again, the use of innovative technologies, which optimize recovery while at the same time are economically feasible, is key to the success of the project. Also important are the various models, including probabilistic economic modeling, dynamic compositional modeling with tubing model development for forecast scenarios, geo-static modeling of all structures, and joint reservoir studies using analogues, fracture modeling, fluid, and rock properties data. Affiliated surface and subsurface infrastructure to accommodate the gas and the associated products is also in the planning and construction phases; proper integration of the value chain is critical as gas, unlike oil, cannot be stored or exported if the LPG capacity is not adequate.

The Kuwait Oil Company has a goal of a maximum of 1% gas flaring by the year 2012, and networks are being put in place that are flexible enough to maintain this target at all times. The aim is to have production of more than 2 bcfpd of total gas, both free and associated, by the year 2015, with all gas being fed to the LPG if possible. By-products will include 6000 tons/day of ethane, propane, and butane and 760 tons/day of sulfur. The total capital investment planned for the next 7 years for gathering, processing and upgrading facilities and wells is estimated at around $8-9 billion.

Currently, six fields in North Kuwait are being developed for gas production, with most of the gas scheduled for the power plants within the State. Found in the Najmah/Sargelu and Marrat formations, the reservoirs are below 14,000 ft, overpressured, naturally fractured carbonates, with critical fluids. Plans are in place to drill 90 wells, and six rigs have been leased to accomplish this goal.

Using the newest technology to maximize well recovery rates, incorporate HSE issues, and find solutions for sour gas will be part of the reservoir development activities. An aggressive, capital intensive gas exploration program will be undertaken during the next five to ten years and will include deeper horizons in the new and existing fields. This aggressive approach, combined with a well integrated and managed gas value chain and the use of new technology will help the Kuwait Oil Company achieve its ambitious goals, thereby ensuring a solid energy future for the State.

Social Responsibility

It is a part of our strategy

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Publications and Documents Available from IGU

As a non-commercial organisation promoting technical and economic progress in the gas industry worldwide, IGU offers its publications free of charge and you are invited to order the IGU publications currently available from the Secretariat. (All documents are A4 format unless stated otherwise and those that can be downloaded from the IGU website are indicated.)

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IGU organisational information

- IGU Articles of Association, (A5).
- IGU Guiding Principles for Sustainable Development.
- News, Views and Knowledge on Gas – worldwide. This general brochure gives a concise introduction to the organisation together with its Vision and Mission.

2009-2012 Programme

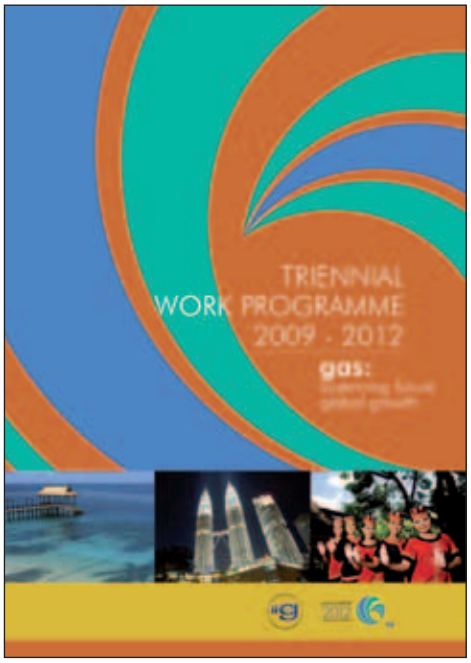
- Triennial Work Programme 2009-2012
- IGU Organisation Chart 2009-2012
- IGU General Brochure
- IGU Annual Report
- Climate Brochure, Natural Gas – Part of the

Solution to Global Climate Changes

- IGU Gas Efficiency Award 2008/2009 & IGU Social Gas Award

Scientific and techical papers and documentation

- Global Natural Gas Perspectives, Nebojša Nakićenović e.o., IIASA, IGU, October 2000 (71 pages, 18 x 25.7 cm). This booklet presents research-based arguments as to how natural gas appears to be suited to provide a bridge from the current energy system to a new era of more environmentally sound energy systems.
- Natural Gas Supply to 2100, M. A. Adelman and Michael C. Lynch, DRI-WEFA, IGU, October 2002, (51 pages, 18 x 25.7 cm). This booklet outlines the authors' assessment of a long-term supply curve for natural gas.
- Proceedings of the 17th, 18th, 19th, 20th and 21st World Gas Conferences, (CD-ROM).



- Proceedings of the 22nd World Gas Conference, Tokyo 2003, (available on www.igu.org).
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- Gas to Power Global Outlook, (brochure,12 pages).
- The Art of Regulation, (brochure, 8 pages).
- International Gas, ISC. All issues of the bi-annual IGU Magazine from 2004-2009.

Individual publications from WGC 2009

- 2030 Report
- CO_2 Report
- Energy Efficiency Model
- Guidelines on Gas Market Integrations
- Best Practices Initiative
- IGM brochure

IGU Events and IGU-related Events 2009-2010

2009

October 5
IGU Council Meeting
Buenos Aires, Argentina

October 5-9
24th World Gas Conference
Buenos Aires, Argentina

October 27-29
3rd Biennial Conference and Exhibition of the Asia-Pacific NGV Association (ANGVA 2009)
Donghae, Korea

December 3
Eurogas General Assembly
Brussels, Belgium

December 7-18
15th session of the Conference of the Parties to the UNFCCC (COP 15)
Copenhagen, Denmark

2010

April 6-8
IGU Executive Committee
Bali, Indonesia

April 18-21
LNG-16
Oran, Algeria

June 8-10
12th World IANGV Conference and Exhibition (NGV 2010)
Rome, Italy

June 17-18
Eurogas General Assembly
Warsaw, Poland

September 12-16
World Energy Congress (WEC 2010)
Montreal, Canada

October 18-22
IGU Council Meeting
Doha, Qatar

November
(exact date to be confirmed)
2nd IEF-IGU Ministerial Gas Forum
Doha, Qatar

You can find links to many of the above events by visiting www.igu.org.

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From IGM to PGC E: IGU.

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HIGH TECHNOLOGY TO SUPPORT DEVELOPMENT

PRA-1 – Autonomous Re-pumping Platform
Brazil

Second bridge spanning the Orinoco River
Venezuela

Capanda Hydroelectric Plant
Angola

Miami International Airport South Terminal
U.S.A.

Lisbon Metro
Portugal

Project for the Expansion of Overland Gas Transportation Capacity - Argentina

For over 60 years, Construtora Norberto Odebrecht has been carrying out infrastructure work that greatly contributes to the development of the countries where the company operates, in such diverse fields as: power generation, transportation, real estate undertakings, industrial plants, sanitation, oil & gas, among other.

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