

FEATURES

This issue's features section starts with a profile of the gas industry in Qatar which is hosting the 2010 Council meeting. Then we have articles on LNG16, which went ahead despite the travel disruption caused by volcanic ash clouds, and this year's new LNG exporter, Peru.

A report from the Task Force "Nurturing the Future Generations" and articles on biomethane, IT and unconventional gas follow. IGU has six new Charter Members and we have profiles on them. We also revisit the work of the Task Force on Gas Market Integration set up during the 2006-2009 Triennium by updating the Iran-Pakistan case study. Finally, we have an update on GECEF, before rounding up with a description of the publications and documents available from IGU and the events calendar.

Meeting the UK's energy needs



His Highness the Amir of Qatar and Her Majesty the Queen at the South Hook Official Inauguration

South Hook is Europe's largest Liquefied Natural Gas (LNG) terminal. Based in Milford Haven, Wales, UK, South Hook has been created as part of the broader Qatargas 2 (QG2) project; the world's first and only fully integrated LNG chain. A joint venture between Qatar Petroleum, ExxonMobil and Total, the QG2 and South Hook project is groundbreaking in terms of size, organisation, finance and strategic importance.

Ground work for construction of the South Hook Terminal began back in December 2004. In May 2009, the terminal was officially inaugurated by His Highness, the Amir of Qatar and Her Majesty the Queen. In 2010, the pioneering project was fully realised at the start of April when Phase 2 construction and final commissioning was completed. The terminal is now fully commissioned and has a total processing capacity of 15.6 million tonnes per annum (MTPA) of LNG and is capable of delivering up to 21 billion cubic metres (BCM) per annum of gas into the National Transmission System (NTS).

The QG2 value chain begins in Qatar's North Field, where 30 wells were drilled to service three offshore platforms.

The gas is piped ashore to Ras Laffan Industrial City, in the north of Qatar, and processed in two giant 7.8 MTPA liquefaction trains (Trains 4 & 5) where the gas is liquefied, cooling it to -162°C , and then loaded onto LNG carriers. Fourteen state-of-the-art vessels were built specifically for the QG2 project. The new Q-Flex and Q-Max vessels are up to 80% larger, and more efficient and economic than conventional carriers. On average, the transportation of LNG from Qatar to South Hook at Milford Haven, Wales is 15 days. South Hook is the final piece of the LNG chain and operates the receiving, temporary storage and regasification terminal which delivers gas into the UK NTS. The facility at South Hook comprises a 1km long jetty with two berths, five tanks (each with a $155,000\text{m}^3$ capacity) and a regasification plant.

South Hook represents a major strengthening of the strategic partnership between Qatar and the UK. It is also the first Qatari involvement in a downstream terminal, making it a major component of Qatar's LNG supply portfolio as the world's leading LNG supplier.

Locally, it is estimated £1 billion will be injected into the economy of Pembrokeshire, Wales throughout

the lifetime of the project. A key value of South Hook is the commitment to working proactively with local stakeholders and communities. South Hook supports good causes and local initiatives through the company's Community Investment Programme, having already contributed over £1 million since it began four years ago.

As a fully commissioned terminal, the South Hook project and the QG2 value chain have been built on working successfully with a range of partners and affiliates. The achievements of this groundbreaking venture will be seen well into the future as the terminal continues to achieve safe, efficient and reliable operations for the supply of Qatari gas to the UK.



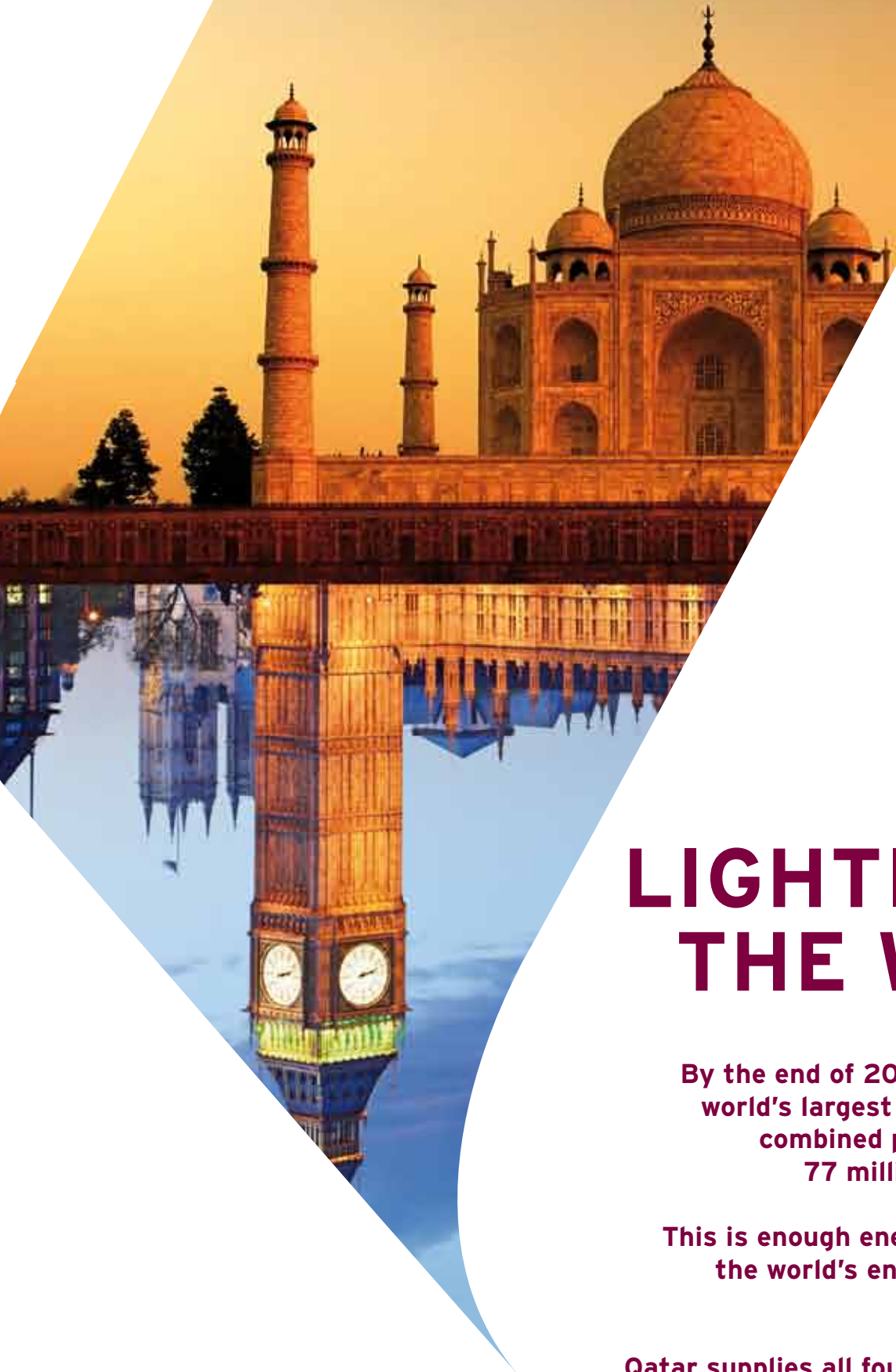
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QATAR
SUPPLYING



MILLION TONNES
OF LIQUEFIED NATURAL GAS PER ANNUM

Qatar Hosts the First IGU Council in the Middle East

By Mark Blacklock

This year the IGU Council is convening for the first time in the Middle East with Charter Member Qatar-gas hosting the meeting in Doha, October 18-22.

Qatar's achievement in becoming the world's largest LNG producer just 10 years after starting exports in 1996 is well known to readers but perhaps less well known is that the origins of the country's petroleum industry date back to the 1930s.

● History

In June 1930 Qatar's then ruler, Sheikh Abdullah bin Qassim Al-Thani, granted an exploration permit to the Anglo-Persian Oil Company (from 1935 Anglo-Iranian and today BP), which was acting on behalf of the international IPC consortium. Following an initial survey, negotiations for a concession started and agreement was reached in May 1935. The concession was duly assigned to IPC subsidiary Petroleum Development (Qatar)



Doha is the venue for the 2010 Council meeting and the 2nd IEF-IGU Ministerial Gas Forum in November.

shortly afterwards and work then started on building up the infrastructure to begin drilling. The first well was spudded in October 1938 at Dukhan, 80 kilometres to the west of Doha. In December 1939 oil was struck and two more wells were subsequently drilled, but then operations were suspended and the wells plugged for the remainder of World War II.

Drilling was resumed in 1947 and the first cargo of oil was exported to India on December 31, 1949. That year also saw the agreement of an offshore concession with the Superior Oil Company. However, Superior found nothing and was succeeded in December 1952 by Royal Dutch Shell. After considerable exploration efforts oil was finally found in commercial quantities in 1960, and offshore exports began in 1964. Meanwhile, Qatar had joined OPEC in 1961.

Offshore exploration continued and although a major non-associated gas find – the North Field – was made in 1971, the time was not right to exploit it. Qatar concentrated on oil and associated gas, setting up the Qatar General Petroleum Corporation (QGPC) in 1974 and nationalising all onshore and offshore operations in 1977. (QGPC changed its name to Qatar Petroleum in 2000.) Associated gas, originally flared, began to be injected for enhanced oil recovery in the 1970s, while natural gas liquids plants were developed in the 1980s.

By now Qatar was ready to start development of the North Field which had been confirmed as the world's largest non-associated gas field with reserves of 25 tcm. Ras Laffan, 80 kilometres to the north of Doha, was chosen as the base of the onshore processing operations and the first phase – dubbed Alpha – came onstream in 1991 to supply gas to domestic markets. Production of gas for international markets under the second phase of development began five years later, and the first LNG cargo from Qatargas 1 was exported to Japan in December 1996. Qatargas 1's three trains originally had a combined capacity of 6.4

mtpa although debottlenecking has since raised this to 9.5 mtpa.

Qatargas joined IGU as an observer in 1997, formally becoming a Charter Member in 2003, and has made valuable contributions to the work of the Technical Committees on LNG. For the current Triennium Alaa Abujbara, Marketing Director of Qatargas, is chairing PGC D with his colleague Abdulla Al-Hussaini, Head of Marketing East of Suez, serving as secretary.

● Development

Qatar was the subject of one of the case studies of IGU's Gas Market Integration Task Force during the 2006-2009 Triennium, which examined how the country has developed an integrated LNG business through strong international partnerships and highlighted its role as a swing producer.

Qatar's geographical location means it can cost-effectively serve both the Atlantic and Pacific Basins.

For Qatargas 1, Qatar Petroleum teamed up with ExxonMobil, Total, Marubeni and Mitsui. For its second LNG project RasGas 1, which started exports in August 1999, it teamed up with ExxonMobil, Kogas, Itochu and Nisso Iwai. LNG capacity has since been steadily expanded – Qatar becoming the world's top producer in 2006 when exports reached 22.7 mt (31 bcm) – and will reach 77 mtpa in 2011, with each project having a separate ownership structure (see *Table 1 over*).

At first Qatar used chartered LNG tanker capacity but then started investing in its own ships through Nakilat which was set up in 2004. The Nakilat fleet consists of 25 wholly-owned and 29 jointly-owned LNG carriers (as well as four jointly-owned LPG ships) including the Q-max class with a capacity of 266,000 m³. The wholly-owned vessels are managed by Shell International Trading and Shipping Company under a deal which will ultimately see operational management transferred to Nakilat.

With production and transportation covered Qatar moved to complete its presence in the LNG



Qatargas 1 shipped Qatar's first LNG in December 1996. The cargo arrived in Japan the following month.

chain by investing in regasification plants. The first of these opened in the UK in March 2009, followed by a facility 15 kilometres offshore Porto Levante in Italy in August 2009. A US plant is expected to open by the end of this year.

Meanwhile other gas developments were underway. In August 2005 a joint Qatargas/RasGas helium facility started production, followed by phase one of the Al Khaleej project supplying



RasGas 1 started exports in August 1999.



Naklilat's first wholly-owned LNG carrier, the 266,000 m³ capacity *Mozah*, was delivered in September 2008. *Mozah* is seen berthed at the South Hook regasification terminal in Milford Haven, UK, in which Qatar Petroleum is the major shareholder.

the domestic market in November 2005. The Oryx gas-to-liquids (GTL) plant shipped its first product in April 2007 and Dolphin Energy began pipeline exports to the UAE in July 2007.

Indeed, the pace was so rapid that the government felt it prudent to declare a moratorium on new gas projects pending evaluation of a strategy to ensure optimal reservoir management and long-term development of the North Field. The moratorium was announced in April 2005, although projects then in the planning stage went ahead, and is not likely to be lifted until 2014.

In 2009 Qatar's gas production reached 89.3 bcm (ranking it 6th in the world) of which 55% was exported as LNG with a further 21% in pipeline exports.

● GTL

Compared to the results from the LNG and pipeline gas sectors, Qatar's GTL sector has had a slower than expected start. At the beginning of the decade projects totalling some 400,000 b/d in capacity were being proposed and Qatar declared its ambition to become the GTL capital of the



Abdullah Salatt, Senior Advisor to Abdullah bin Hamad Al-Attiyah, Qatar's Deputy Prime Minister and Minister of Energy & Industry (CENTRE LEFT) with Qatar Airways CEO Akbar Al-Baker (CENTRE) and senior GTL consortium representatives, on arrival at Doha airport following the historic GTL-fuelled commercial flight from London.

world. It has indeed become the world's largest GTL producer but not at the volume originally envisaged.

The moratorium led to the shelving of a number of proposals and then problems were experienced in scaling up the low-temperature slurry phase distillate (SPD) process used in the first plant – a joint-venture of Qatar Petroleum (51%) and Sasol (49%) called Oryx. Sasol had developed and successfully trialled SPD but the initial move to large-scale production resulted in a higher than design level of fine material in the

paraffinic wax produced in the reactors, which in turn constrained output. The initial output in 2007 was 6,000 b/d compared to the 34,000 b/d capacity announced when the plant was launched.

Since then the problems have been addressed and output gradually increased, reaching 30,000 b/d in the first quarter of 2010. Oryx produces diesel, naphtha and LPG and has taken over responsibility for product marketing from its shareholders. The plant's design capacity is now quoted as 32,400 b/d and a debottlenecking project has been started. This will initially boost

BELOW
Table 1.

QATAR PETROLEUM (QP) IN THE LNG CHAIN

Liquefaction plant	Capacity) (mtpa)	Shareholders	First export
Qatargas 1 (Trains 1-3)	9.5	QP 65%; ExxonMobil 10%; Total 10%; Marubeni 7.5%; Mitsui 7.5%	1996
Qatargas 2 (Train 4)	7.8	QP 70%; ExxonMobil 30%	2009
Qatargas 2 (Train 5)	7.8	QP 65%; ExxonMobil 18.3%; Total 16.7%	2009
Qatargas 3 (Train 6)	7.8	QP 68.5%; ConocoPhillips 30%; Mitsui 1.5%	2010
Qatargas 4 (Train 7)	7.8	QP 70%; Shell 30%	2011
RasGas 1 (Trains 1-2)	6.6	QP 63%; ExxonMobil 25%; Kogas 5%, Itochu 4%, Nisso Iwai 3%	1999
RasGas 2 (Train 3)	4.7	QP 70%; ExxonMobil 30%	2004
RasGas 2 (Train 4)	4.7	QP 70%; ExxonMobil 30%	2005
RasGas 2 (Train 5)	4.7	QP 70%; ExxonMobil 30%	2007
RasGas 3 (Train 6)	7.8	QP 70%; ExxonMobil 30%	2009
RasGas 3 (Train 7)	7.8	QP 70%; ExxonMobil 30%	2010
Shipping company		Shareholders	
Nakilat		QP 5%; Qatar Navigation Co. 15%; Qatar Shipping Co. 15%; Qatar Pensions Fund 7%; Qatar Foundation 5%; Qatar Education & Health Fund 2%; Qatar Fuel Co. 1%; traded 50%	
Regasification terminal	Country	Shareholders	First delivery
South Hook LNG (Milford Haven)	UK	QP 67.5%; ExxonMobil 24.15%; Total 8.35%	2009
Adriatic LNG (Offshore)	Italy	QP 45%; ExxonMobil 45%; Edison 10%	2009
Golden Pass LNG (Texas)	USA	QP 70%, 30% shared by ExxonMobil and ConocoPhillips	2010

capacity by 3% by the beginning of 2011 with a further 7% by 2013.

Oryx will soon be joined by Pearl GTL which is an integrated upstream and downstream project (Oryx buys its feedstock gas from the Al Khaleej project). Pearl is being developed under a Development and Production Sharing Agreement between Qatar Petroleum and Shell, with Shell providing 100% of the project funding.

Pearl will produce 44.8 mcm/d 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 using Shell middle distillate synthesis (SMDS). The GTL product slate will comprise naphtha, normal paraffin, kerosene, diesel and base oils. Construction is due for completion at the end of the year, with commissioning of Train 1 in 2011 followed by Train 2 in 2012.

Shell is not anticipating problems in scaling up GTL production compared to its current use of SMDS at the 14,700 b/d Bintulu plant in Malaysia. It points out that the multi-tube fixed bed reactor design allows the size of each reactor to be increased by simply multiplying the number of tubes. However, all eyes will be on Ras Laffan during Pearl's ramp-up.

One important local customer of Pearl will be Qatar Airways which is keen to start large-scale use of GTL jet fuel. The carrier operated the world's first commercial flight fuelled wholly by a GTL blend on October 12, 2009, when an Airbus A340-600 powered by four Rolls-Royce Trent 556 engines flew from London Gatwick to Doha using a 50:50 blend of GTL kerosene from Shell's Bintulu plant and standard jet fuel. In the only departure from a normal flight the aircraft's auxiliary power unit was not used as it had not been certified for use with GTL fuel.

The flight was the culmination of over two years of scientific work carried out by a consortium consisting of Airbus, Qatar Airways, Qatar Petroleum, Qatar Science & Technology Park,

Qatar Fuel (WOQOD), Rolls-Royce and Shell, much of which was undertaken at the Qatar Science & Technology Park in Doha. GTL jet fuel burns with lower sulphur dioxide, nitrogen oxides and particulate emissions than pure conventional oil-based kerosene, contributing to improved local air quality at airports. It also has a slightly higher energy density resulting in a slightly lower fuel burn.

● **Economic diversification**

Commercialisation of the North Field has made a major contribution to the rise in Qatar's GDP which quadrupled in real terms between 1996 and 2009. But while the petroleum industry will continue to play a major role in the country's economy for the foreseeable future, national policy is to diversify income sources.

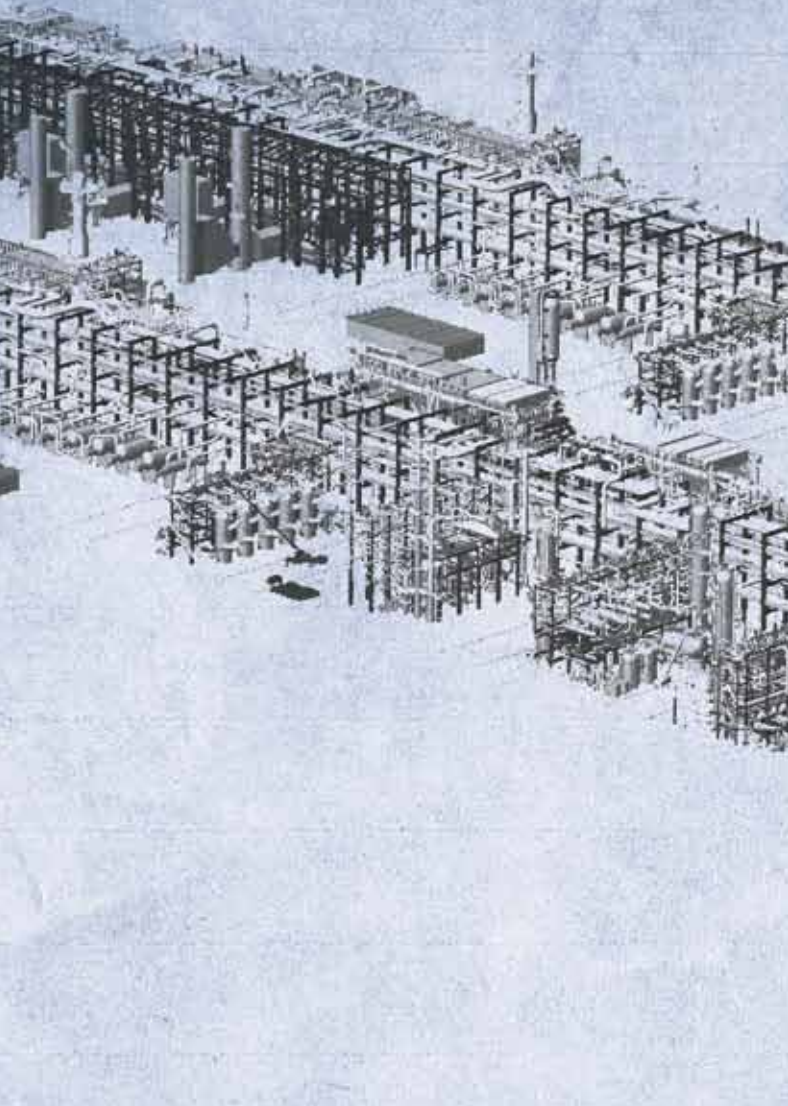
Qatalum, a joint venture of Qatar Petroleum and Norway's Hydro, opened a 585,000 tonne aluminium plant last year, while construction, real estate and financial services are seen as important economic drivers. The government is investing heavily in the country's infrastructure with projects such as the new Doha airport, which is being built on reclaimed land adjacent to the existing airport and is due to open in July 2011, Lusail City immediately to the north of Doha, which will ultimately house 200,000 people, and the Museum of Islamic Arts designed by I. M. Pei, one of a series of landmark buildings along Doha's Corniche.

Equally as important as investment in infrastructure is investment in people with projects such as the Science & Technology Park and Education City, both sponsored by the Qatar Foundation for Education, Science & Community Development.

It will not just be delegates to the 2010 Council meeting who will be able to see these developments for themselves. The following month, on November 30, Qatar hosts the 2nd IEF-IGU Ministerial Gas Forum.

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

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LNG16 – Triumph over Adversity

By Ernesto López Anadón, Abdul Rahim Hashim, Alain Goy, Philip Hagyard and Mohammed Taleb

The 16th triennial International Conference and Exhibition on LNG was scheduled to take place in Oran, Algeria, April 18-21. This time it was the turn of an LNG exporting country to host the event, which is sponsored by IGU, the International Institute of Refrigeration (IIR) and the Gas Technology Institute (GTI).

There are many eventualities to plan for when mounting a large international conference, but the eruption of a volcano 4,000 kilometres from the venue which had been dormant for nearly two centuries was not something the organisers of LNG16 could have imagined in their wildest dreams – or nightmares.

NUMBER OF DELEGATES PER REGION

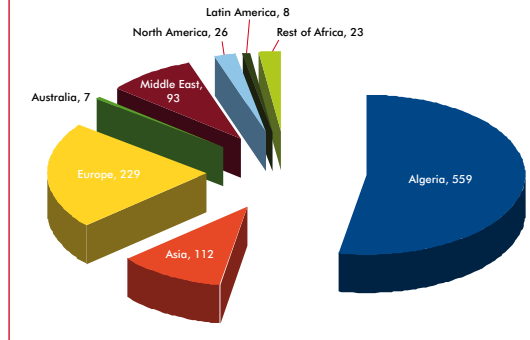


Figure 1.

When Eyjafjallajökull spewed a cloud of volcanic ash into the atmosphere which paralysed air traffic in northern Europe from April 15 to 20, the travel plans of LNG16 delegates from or routing through Europe were badly affected. Some were delayed in their arrival and many were not able to attend at all. However, a swift response



Oran was the venue for LNG16 – the two cruise ships were brought in to provide additional accommodation.

from the Algerian National Organising Committee (NOC), conference organiser ITE and the LNG16 Steering (SC) and Programme (PC) Committees mitigated the impact.

The conference start was delayed to allow as many people as possible to get to Oran and the programme condensed from three and a half to two days. Some stranded speakers nominated substitutes to give their papers while two recorded podcasts. In the end 1,057 delegates made it to LNG16 of which 559 were from Algeria (see *Figure 1*). Although this compares with an anticipated 2,000 delegates and 3,000 at LNG15 in April 2007, it was a creditable result in the face of such adversity. And for those who registered but



Over 1,000 delegates made it to LNG16.

BELOW The master of ceremonies introduces the top table at the opening of LNG16. FROM LEFT TO RIGHT: Alain Goy, Vice Chairman of the LNG16 Programme Committee; Ernesto López Anadón, Chairman of the LNG16 Steering Committee and Immediate Past President of IGU; Awadh Said Al-Socotri, Yemen's Minister of Electricity & Energy; Dr Chakib Khelil, Algeria's then Minister of Energy & Mines; Tahar Sekrane, Wali of Oran (equivalent to Prefect); Dr Abdelhafid Feghouli, acting CEO of Sonatrach and Chairman of the LNG16 NOC; and Aleksandr Valentinovich Egorov, Russia's Ambassador to Algeria.





before the travel restrictions started. Occupying a net 8,850 square metres, it opened as planned on April 18 and there were 178 exhibiting companies from 34 countries. The exhibition was managed by ETF which has had the contract since LNG12.

● **Reorganisation**

As soon as the implications of the eruption became clear, efforts to reorganise LNG16 began. The first step was the postponing of the opening ceremony to 18:00 on April 19 following consultations between Dr Chakib Khelil, Algeria's then Minister of Energy & Mines, Dr Abdelhafid Feghouli, NOC Chairman, and Ernesto López Anadón, SC Chairman.

Then, on April 17, the SC members in Oran at that point (Ernesto López Anadón, Abdul Rahim Hashim, Alain Goy and Mohammed Taleb) decided to condense the programme into two days and asked the PC to reorganise it.

were unable to travel, all the presentations were videoed and made available for downloading from the LNG16 FTP site.

The exhibition was less affected, principally because the exhibitor teams arrived in Oran



TOP AND ABOVE The exhibition ran as planned.

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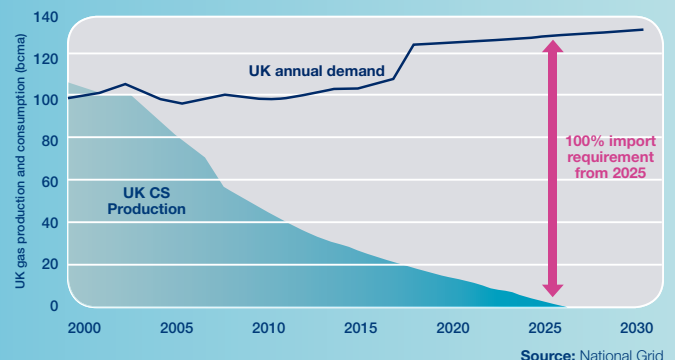
Catching the tide

Centrica is the leading buyer in the world's most attractive gas market

The UK is one of the world's most gas intensive economies with strong demand and an import requirement set to grow as UK supply falls at up to 10% per annum. 50% of UK supply was imported in 2009. This growth of imports is much faster and of larger quantum than even China. The scale, flexibility and transparency of the UK market ensures that the UK will become an important factor in the world LNG trade.



UK gas supply/demand



“There is a tide in the affairs of men.
Which, taken at the flood, leads on to fortune;
...On such a full sea are we now afloat,
And we must take the current when it serves,
Or lose our ventures.”

William Shakespeare Julius Caesar, Act 4, Scene 3, 218-224

The PC Chairman, Dr Nirmal Chatterjee, was stranded en-route to Oran but made a proposal via email which was considered during an extraordinary PC meeting on April 18. This was chaired by Alain Goy and attended by Antonio Hernando, Takashi Kuroko, Max Nussbaum and Jim Solomon. A representative of ITE was also present who had been able to track the travel status and whereabouts of all the speakers. A new programme was approved just before the opening of the exhibition.

The shortened revised programme was adjusted continuously to adapt to the circumstances with changes given every day by ITE to delegates. None of the delegates complained about lack of information in spite of the short notice and they managed to find the right rooms and sessions without too much difficulty.

● The programme

The opening ceremony took place on April 19 with dignitaries led by Dr Chakib Khelil presiding. It was followed by a reception and gala dinner held under a marquee built on the terrace of the Oran Convention Centre between the auditorium and the exhibition hall.

The Plenary Session on April 20 was chaired by António Órfão, CEO of Sonangol Gás Natural, who gave an overview of developments in Angola, which is set to become an LNG exporter in 2012. He then introduced Dr Noé van Hulst, Secretary General of the International Energy Forum (IEF), who presented the key results of the latest IEF ministerial meeting. These are held every two years and the 12th was held in Cancun, Mexico, March 30-31.

Plenary Session 2 was cancelled and replaced by a roundtable on April 21 looking at "Perspectives on the future of LNG". It was chaired by Abdul Rahim Hashim with representatives from three regions: Francisco de la Flor García, Director – Regulation of Enagás (Europe), Jay Copan, Executive Director of LNG17 (USA) and

Katsumi Kuroda, Senior Vice President – Energy Business of Mitsubishi (Asia).

There were six paper sessions running in parallel and two workshops (see Figure 2). A reduced poster session with 23 posters was held in parallel with the second workshop on April 21.

While presentations covered the latest developments throughout the LNG chain, the hot issues were the short-term impact of the economic downturn and the longer-term impact of growing supplies of unconventional gas particularly in the US. Clearly the US is not going to be the driver of LNG growth once envisaged, but speakers asserted that it retained an important role in the business while other markets offered growth potential. Indeed, the global LNG trade grew 7% in 2009 compared to a drop in overall gas consumption, and Brazil, Canada, Chile and Kuwait joined the ranks of importers.

However, market share increased at the expense of lower spot prices, so-called flexible LNG accounting for 27% of trading last year. Some 44 mtpa of new liquefaction capacity was inaugurated over the course of 2009 and its full

PAPER SESSIONS (PS) AND WORKSHOPS (WS)

- PS** The market outlook for LNG after the global recession
- PS** Floating plant and safety – part 1
- PS** Technology development
- PS** Plant construction, start up and operations
- PS** New commercial terms
- PS** Floating plant and safety – part 2
- WS** Evolution of the LNG market in changing times – long or short?
- WS** Technical innovations for the future of the LNG business

Figure 2.

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effect is being felt this year when a further 24 mtpa is being added. Speakers predicted continued downward pressure on spot prices in the short term but a recovery by 2012 as additions to liquefaction capacity tail off and demand increases.

● **Side events and closing ceremony**

A pre-conference course “Introduction to LNG” had been planned and this was postponed to April 21 with William Schmidt, Technology Manager LNG Process of Air Products, substituting for Dr Nirmal Chatterjee and Chris Caswell, LNG Technology Manager of KBR, substituting for Colleen Taylor Sen, while Alain Goy participated as originally planned.

Two technical visits to the Arzew LNG facilities were offered with 272 delegates taking part in the

first visit on April 20 and 528 in the second on April 21.

The closing ceremony was held in the early evening of April 21 and the conference banner was handed to Jay Copan, Executive Director of LNG17, which will be held in Houston, April 16-19, 2013.

Ernesto López Anadón is Chairman of the LNG16 Steering Committee (SC) and Immediate Past President of IGU, Datuk Abdul Rahim Hashim is President of IGU, Alain Goy is Head of the LNG Technical Department at Elengy, Vice Chairman of the LNG16 Programme Committee and an IIR commission member, Philip Hagyard is Senior Vice President of the LNG/GTL Business Unit at Technip, a member of the SC and an IIR Commission member, and Mohammed Taleb is CEO of Helios and Vice President of the LNG16 NOC.



Dr Abdelhafid Feghouli (LEFT) hands over the conference banner at the closing ceremony to Jay Copan, Executive Director of LNG17, while Dr Chakib Khelil (CENTRE) and Ernesto López Anadón (RIGHT) look on.

THE ENERGY LIVES HERE





Peru Joins the Ranks of LNG Exporters

By Mark Blacklock

In June Peru LNG shipped its first cargo marking the culmination of the challenging Camisea project to expand the gas industry in Peru.

The Camisea contracts covering gas fields in the region of Cusco were signed in 2000, and the first phase came on stream in August 2004 piping gas to the Lima/Callao metropolitan area and natural gas liquids (NGL) to a fractionation plant at Pisco. Prior to that Peru's gas industry was limited to the Aguaytía gas and power project in the region of Ucayali and a number of injection projects in the oil industry, with consumption averaging 0.4 bcm/year. By 2009 this had surged to 3.5 bcm amounting to 19% of the country's primary energy consumption. At full capacity Peru LNG will take a further 6 bcm/year.

Indeed, the success in developing the domestic industry aroused fears amongst some local politicians about how long the Camisea reserves would last, and there were calls to ring-fence them for domestic use. Peru's Ministry of Energy & Mines addressed the issue by commissioning a new independent survey and the results were released in May. The survey confirmed proved reserves in Blocks 56 and 88 of 310 bcm plus 346 million barrels of NGL and 265 million barrels of condensates, with a further 56 bcm in Block 57, sufficient to meet a contracted 20-year supply to Peru LNG and longer-term domestic demand as originally projected.

Announcing the results of the survey to the Peruvian Congress the Minister of Energy & Mines, Pedro Sánchez, pointed out that exploration work continued in Block 58 and that a pipeline supplying the south of the country, the Gasoducto Andino del Sur, would be in operation by 2015.

The Camisea project – named after the Camisea River – has been challenging on all



The LNG tanker *Barcelona Knutsen* exported Peru LNG's first cargo.

fronts. The gas fields are in a remote area of unique biodiversity, and to get the gas to market it has to be piped across the Andes reaching an altitude of 4,900 metres before dropping down to sea level. The potential for environmental damage and harm to local people made exploiting the Camisea gas resources controversial from the start, and a comprehensive outreach programme was developed as an integral part of both phases of the project.

Pluspetrol of Argentina is the upstream operator of Blocks 88 and 56 and its partners are Hunt Oil, SK Energy, Sonatrach, Repsol and Techint subsidiary Tecpetrol. There is a gas processing plant at Malvinas from which product is dispatched via the pipelines. These are operated by Transportadora de Gas del Perú (TGP), which is owned by a consortium of the upstream partners plus Graña y Montero of Peru and GDF Suez subsidiary Tractebel Engineering. The NGL pipeline runs for 560 kilometres to Pisco, while the gas pipeline to Lima is 730 kilometres long. The first 210 kilometres of the latter were built with a larger diameter to provide reserve capacity and avoid the need for additional pipelaying in a particularly ecologically sensitive area.

Blocks 57 and 58 are operated by Repsol and Petrobras respectively, and the southern pipeline will be operated by Kuntur Transportadora de Gas, a joint venture of Brazil's Odebrecht and Conduit Capital Partners from the US. This will run for 1,085 kilometres serving the regions of Arequipa, Puno and Moquegua.

● Peru LNG

The reserve capacity in the first section of the TGP pipeline now serves the Peru LNG project, which is led by Hunt Oil (50%) with Repsol (20%), SK Energy (20%) and Marubeni (10%) as partners. Marubeni agreed to join the original three shareholders in 2007.

Peru LNG comprises a 408-kilometre pipeline branching off the TGP line to a liquefaction plant



The liquefaction plant is on the Pacific coast at Pampa Melchorita.

on the Pacific coast at Pampa Melchorita, 170 kilometres south of Lima, and a marine terminal. The Air Products propane pre-cooled mixed refrigerant process was chosen and the single train has a nameplate capacity of 4.45 mtpa. The plant is located on a plateau above sea level to give tsunami protection and there is a 140-metre drop to the marine terminal which has a 1.3-kilometre jetty, a tug boat dock with a 200-metre breakwater and a main 800-metre breakwater.

The final investment decision for Peru LNG was made in 2006 against a background of escalating engineering, procurement and construction costs. Moreover, the pipeline element faced the same challenges as TGP in crossing the Andes, while the liquefaction plant is in a zone of high seismic activity and had to be built to withstand an earthquake of up to 8.6 on the Richter scale. The contract strategy was to seek separate bids for the



marine terminal and liquefaction plant with the pipeline element split into separate packages for design engineering, line pipe procurement and pipeline construction. The consortium managed to lock in capital costs for the liquefaction plant (built by CB&I) of \$1.6 billion or approximately \$360 per tonne of annual capacity. Pipeline, marine terminal, other project and financing costs brought the total budget to \$3.8 billion.

As Peru LNG's General Manager Barbara Bruce and Deputy General Manager Carlos Lopez-Piñon explained in a paper presented at WGC2009, the target was to raise 60% of the investment as project finance with the balance as equity, and the deal was closed in June 2008 just three months before the global financial crisis broke. It was Latin America's largest project financing.

Repsol has an 18-year sale and purchase agreement for Peru LNG's output, and a major customer will be Mexico's Comisión Federal de Electricidad (CFE) through a regasification terminal

being built at Manzanillo which will supply gas to CFE power plants. The Manzanillo terminal is expected to open in September 2011 and in the meantime cargoes will be sold on the spot market.

Three new dual-fuel diesel-electric LNG tankers of 173,400 m³ built by DSME in Korea are dedicated to Peru LNG and a fourth can be brought in if needed. The first two ships were delivered in April and May. They are owned by Knutsen OAS Shipping and managed by Stream, a joint venture of Repsol and Gas Natural.

Although Peru LNG has been developed as a single-train, 20-year project, the pipeline has spare capacity and provision at the liquefaction plant has been made for a second train. Whether it will be expanded will depend on how successful exploration efforts are in finding more gas reserves in Peru.

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



Laying the pipeline to supply Pampa Melchorita.

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Nurturing the Future Generations

By Soh Mey Lee

The Malaysian Presidency of IGU considers encouraging young people to seek careers in the global gas industry as an important aim and has set up a Task Force to look at “Nurturing the Future Generations”.

Globally, economic activities and the progress of people around the world are driving demand for more energy. Despite the economic slowdown over the last year or so, the appetite for more energy will continue to grow for two primary reasons: expansion of the real economy with global GDP growth projected at 2% to 3% per

annum until 2030 on a market exchange rate basis and world population that will also continue to balloon to around 8 billion people by 2030.

Living standards should also improve with a growing middle class population worldwide and energy use by homes, vehicles and industries should go up. By 2030, it is projected that the world will need at least 60% more energy than in the year 2000. Energy demand growth is driven by rising demand for electricity and most likely this will be met by natural gas as the fuel of choice. In the quest for a cleaner environment and a more stable climate, the world is also looking to gas as the fuel of choice.

The global gas industry plays a vital role in the equation for economic recovery and growth but, in recent years, workforce issues have become one of the most critical challenges facing the petroleum



ABOVE AND OPPOSITE It is important to interest young people in science and engineering.

industry. Many factors are leading to the talent crunch that the global gas industry is facing.

One of the most notable factors is the nature of the “boom-bust” cycles of the petroleum industry that led to massive lay-offs in the past as well as in the recent aftermath of the global financial crisis. While the industry as a whole was slow in recruiting, the downward slide in global oil and gas prices resulted in lower margins that led to drastic cost-cutting measures.

Apart from the need to restructure and consolidate, the global petroleum industry is also experiencing the infamous “great crew change” as the skills and expertise of the existing, ageing workforce are lost on retirement. According to a 2004 survey conducted by the American Petroleum Institute (API), the average age in the oil and gas industry is 49 years and this is among the oldest in comparison to any other industry.

Again, in comparison to other industries, the petroleum industry has a long lead time for “experience” to develop. In many cases vital institutional knowledge of technology-focused companies is lost simply because, in a globalised world, talent is geographically and culturally mobile. Hence, although the highly skilled take a long time to produce, once they are trained they may easily move to what they perceive to be greener pastures.

● **Attracting young people**

Going forward, the need for talented scientific and technical professionals will be even more crucial given that continuous innovation and technology breakthroughs will be necessary to support the future sustainability of natural gas supply and usage amidst higher environmental considerations and expectations.

Innovation is key to any big leap forward and innovation requires talented people, but we all know that “talent” is in short supply and must be developed to meet the challenges that the industry is facing. According to a survey conducted by



Schlumberger in 2007 the projected shortfall of petro-technical professionals in 2012 may be as high as 28%.

In fact, innovation is also necessary to improve the economics of developing unconventional resources. It is estimated that world unconventional gas resources in the form of coal-bed methane (CBM), shale gas and tight sand gas add up to over 30,000 tcf (840 tcm). However, further efforts in unconventional gas will depend entirely on advances in technology and the viability of such technology again will depend on long-term gas prices to support the commercial viability of such developments as well as the ingenuity of engineering feats.

Nurturing talent will be a big leap forward for the global gas industry as the younger generations of today and tomorrow have incredible opportunities for a diverse array of careers. In some countries fewer and fewer young people are enrolling in science, technical, engineering and mathematics (STEM) courses. There has been more than a 90% drop in the number of students obtaining university degrees in petroleum engineering and geosciences since 1982.



Task Force members Jitka Adamkova (FOREGROUND) and Agnès Grimont enjoying a light-hearted moment at Petrosains, The Discovery Centre during a technical visit in January.

Some surveys attribute this to either a lack of awareness and engagement with the oil and gas industry or simply poor perceptions of it as a “sunset” industry or one that is polluting the environment.

Those who may have enrolled in science and engineering courses also will have tremendous career opportunities in pharmaceuticals, biotech, veterinary fields, law policy, ICT and television, biotechnology and so forth.

Competing for talent will require “out of the box” thinking and a long lead time. What is important is for the industry to really know and understand the career aspirations of young people and perhaps their sense of purpose and meaning in their work-life balance.

● **WGC Youth Programme**

For the first time at a World Gas Conference, the Malaysian Presidency intends to engage the future generations through a Youth Component Programme. This will be organised by Task Force 2

during the 25th WGC in Kuala Lumpur, June 4-8, 2012.

Apart from a “Generational Blueprint” the Youth Component Programme will incorporate several activities including on-site as well as on-line activities using web-based tools to reach out to young people worldwide and engage them in a chat forum to raise their interest and awareness of the gas industry.

For example, when we call on students from under-represented populations to consider becoming a scientist or engineer, they need to see the role models leading the learning, research, societies and communities in STEM fields.

Task Force 2 seeks your good ideas to take back, to discuss, and to think about how the gas industry can perhaps tweak our programmes to address the talent issues with the younger generation.

Developing talent is necessary to match the phenomenal pace of growth of the industry and meet the higher technical requirement of advanced technologies and tougher operating conditions. Certainly, we cannot sit back and wait for the education system or academics to deliver the talent we need. We need to recognise and address the fact that this is a critical part of our staffing and workforce development investment and take proactive measures to arrest the decline in the talent pipelines.

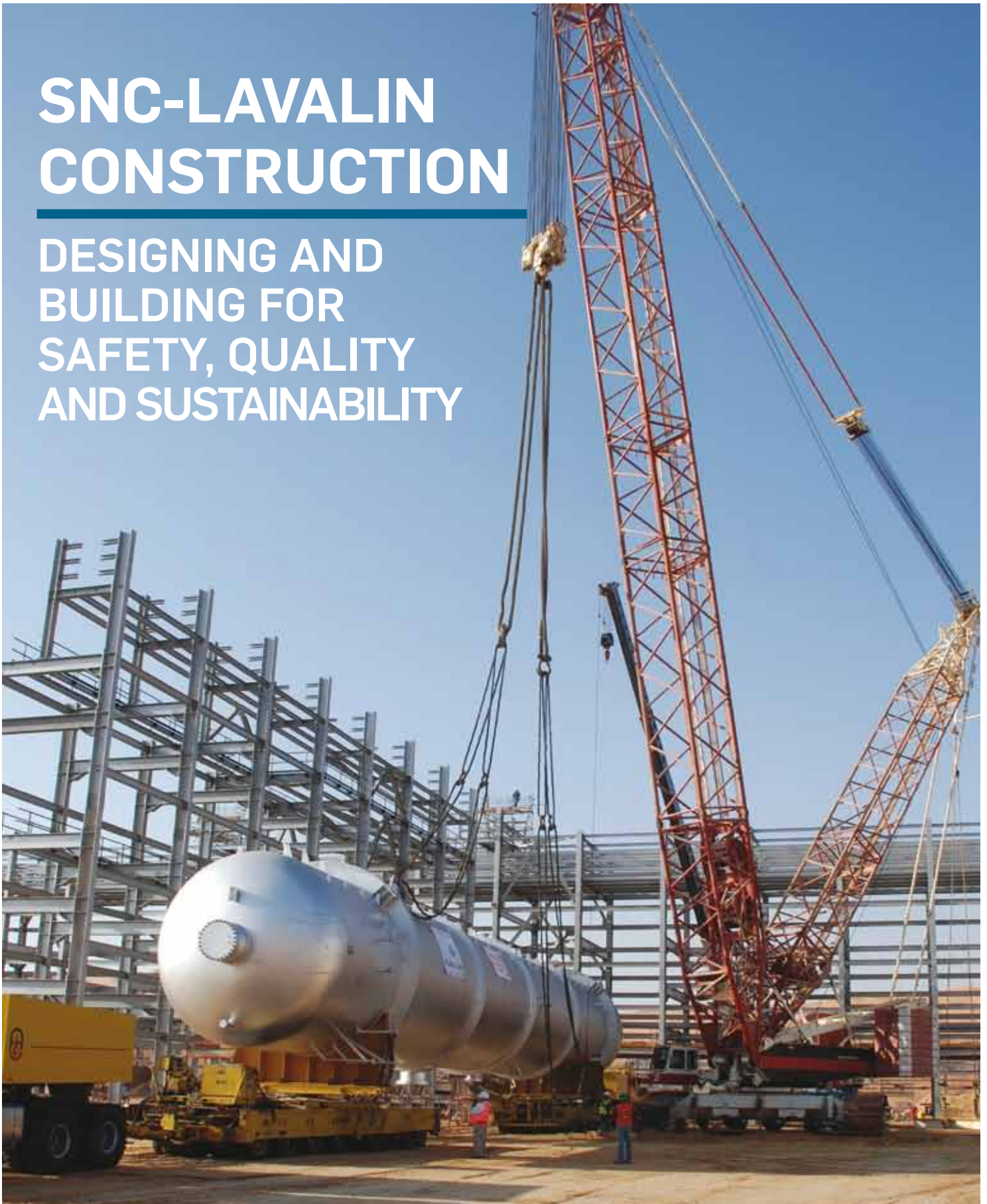
Task Force 2 aims to develop a holistic approach to nurturing the future generations to engage and excite the younger generation about science, technology, engineering, mathematics and energy (specifically the gas industry). The approach includes creating awareness and preparedness of the young generations for the oil and gas industry (energy) and other STEM-oriented careers at all educational levels.

All of us in Task Force 2 look forward to keeping you updated on our work.

Soh Mey Lee is the Chair of Task Force 2.

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Biomethane Projects Multiply

By Adrian Giddings

As IGU's Working Committee 5 – Utilisation has identified, biomethane can play an important role in a sustainable energy policy. The attraction of using waste products as feedstock is driving projects around the world, although their individual economics depend on the interplay of local fiscal incentives and waste management policies such as landfill taxes.

Biomethane is produced in two ways, firstly by the fermentation or anaerobic digestion of bio-

degradable materials such as manure, sewage or municipal waste to produce biogas which is then upgraded, and secondly via the gasification of solid biomass to produce syngas for reforming. In each case the main expense is the treatment of the intermediate gas to produce biomethane to the specifications of natural gas.

Biomethane produced from landfill sites or organic waste material is particularly interesting as it avoids the venting to the atmosphere of methane, which is a more damaging greenhouse gas than CO₂.

France is one of the latest countries to start a landfill project. At Claye-Souilly near Paris Veolia has been running a plant producing biomethane from landfill biogas since September 2009. The plant extracts CO₂ and nitrogen from the raw biogas, removes pollutants and outputs biomethane which is then compressed to 300 bar to fuel eight light vehicles and one household waste truck. Two different methods of separating the CO₂ and nitrogen from the methane are being evaluated, one using porous solids while the other uses a membrane system. The most cost-effective



Veolia's landfill biomethane production facility at Claye-Souilly in France (ABOVE). Refuelling the site's household waste truck (INSET).

method will be used in similar plants at other waste landfill sites.

According to Christophe Aran, Deputy Director of Veolia Environnement's R&D centres: "The future for this research programme is very significant given that the facilities operated by Veolia Environnement worldwide – over and above its landfill sites – produce in the order of 750 mcm of methane a year. The programme makes it possible to recover biogas directly, either as fuel for use by the vehicles that deposit the waste or by Veolia Transport's bus fleets, or as biomethane that can be injected into the natural gas transmission and distribution network."

The French initiative follows pioneering work in Sweden – Europe's biomethane leader – and projects in Spain and the UK (see *International Gas*, October 2008, pages 168-172). In the UK the landfill site operated by Gasrec outputs liquid biomethane (LBM) which is used in waste trucks, goods vehicles and most recently for a bus trial.

Having operated one delivery truck since August 2008 between its flagship green store in Dartmouth and a depot in Bristol, Sainsbury's has

ordered a further five Genesis Dual-Fuel units manufactured by Clean Air Power to be retrofitted to their fleet. These units allow up to 50% of the diesel normally used as fuel to be substituted for liquid biomethane for a CO₂ emission reduction of around 30%. Clean Air Power has also signed a letter of intent with Volvo to develop an interfaced version of the technology. Unlike the Genesis units the interfaced version of the technology must be developed in tandem with the engine manufacturer as the the dual-fuel unit works directly with the truck's engine management system to allow a substitution of up to 90% of the diesel with biomethane.

In November 2009 a bus trial started at East Midlands Airport, which is working towards a target of being carbon neutral by 2012. This target covers all the operational processes under the airport's direct control. The airport partnered with Gasrec in a six-month trial of a Cobus 3000 passenger transfer bus. At press time the final report on the trial was still being prepared but initial data shows a very promising outcome. Neil Robinson, Director of Sustainability, East Midlands



This LBM-fuelled bus was trialled at East Midlands Airport in the UK.

Airport said: “The six month trial was very successful and the results showed that the bus produced considerably less CO₂ emissions, a significant improvement in air quality and an operational cost saving, when compared to a similar bus fuelled by diesel. The airport is looking to introduce biomethane-fuelled buses on a more permanent basis, as part of the natural expiration process of our current passenger transfer bus fleet.”

The UK’s first biomethane-fuelled bus was unveiled in September 2009 in Norwich. The consortium behind the new bus is led by the University of East Anglia’s Low Carbon Innovation Centre and includes operator Anglian Bus, manufacturer Optare and engine conversion specialists Hardstaff Group. In this trial the biomethane is compressed. “Dual-fuel use is a very attractive option,” says project leader Dr Bruce Tofield. “The vehicle can still run on diesel, providing flexibility, but most of the time is running on biomethane which is a much cleaner and less polluting fuel. In particular, the cost of conversion of a diesel bus to dual-fuel use is a small fraction of the cost of a new natural gas bus. Conversion to dual-fuel use is potentially a viable option for most if not all diesel buses in the UK and, indeed, across Europe and more widely.”

● **Developing future policies**

Part of the funding for the Norwich project came from the European Union-sponsored Civitas Initiative which aims to assist cities in the development of more sustainable, clean and energy efficient urban transportation systems via both technological and policy-based means. The EU has committed to reaching a 20% share of renewable fuels in the region’s energy mix and saving 20% in energy use by 2020. The transportation sector has an important role in the achievement of this “20:20:20” target.

The European Commission hosted a high-level conference on the future of the European transport system in Brussels on November 20, 2009, the

second and final public consultation that will lead to the publication of the Commission’s White Paper on the future of transportation in the region from 2010-2020. During the conference Matthias Ruete, Director General of DG Transport and Energy (DG TREN), recognised that the Commission should re-evaluate the contribution of natural gas/biomethane to a sustainable future for transport.

Meanwhile, as part of IGU’s Technical Work Programme, a joint study on biomethane is being coordinated by PGC A (Sustainability) with input from WOC 5 (Utilisation) and PGC E (Marketing).

● **Norway’s ambitious target**

Oslo has ambitious plans to be a green capital city as part of Norway’s aim to be a carbon neutral country by 2050. Ruter, Oslo’s municipal bus company, is furthering the use of biofuels in its fleet. All its diesel-fuelled buses run on a mix of diesel and biodiesel, and in 2008 it began to run the 20 buses on one of its routes with 95% bio-ethanol. A further stage of biofuel development was scheduled to begin at press time with the test running of 18 buses on biomethane. The biomethane is produced by one of the city’s sewage plants where the gas used to be flared off into the atmosphere. Taking into account the electricity used in the sewage plant to convert the gas, Oslo City Council calculates that carbon emissions from each bus will be 18 tonnes per year, which is a saving of 44 tonnes over a bus running on standard diesel.

● **Thailand’s decentralised distribution**

Another advantage of biomethane is its potential to provide a decentralised supply of energy to communities living far from sources or distribution channels of conventional hydrocarbon fuels.

In Thailand PTT is investing in biomethane development with a research and demonstration project aimed at improving the quality of biomethane as a vehicle fuel. PTT is the only distributor of natural gas for vehicles in the country and



Oslo has ambitious plans to be a green capital city as part of Norway's aim to be carbon neutral by 2050.

is looking for ways to expand gas-powered vehicle use in areas which are far from existing energy infrastructure. Current opportunities to expand the country's NGV filling station network are limited by the need for stations to be situated along natural gas pipelines.

The plan is to produce compressed biomethane as a new vehicle fuel by late 2010. Focusing on biogas derived from waste water treatment and the treatment of agricultural surplus or scrap in factories, the biomethane will be produced in Ubon Ratchathani. Economic studies will be completed with a view to expanding to other areas of the country.

- **No reduction in performance**

At the other end of the spectrum of vehicle usage, Volkswagen has seen great success in recent years with its Scirocco GT24-CNG.

In 2009, Volkswagen entered two CNG-fuelled versions of the vehicle in the famous and gruelling 24-hour race at the Nürburgring-Nordschleife circuit in Germany coming 17th overall and

winning the category for vehicles with alternative powertrains.

In this year's race three of the 300hp coupés were entered, this time powered by compressed biomethane. Their 2.0-litre turbocharged engines reduce CO₂ emissions by 80% over a conventional petrol engine.

In front of 220,000 spectators the Sciroccos dominated their class taking all three spots on the podium and winning the FIA Alternative Energy Cup in the process. In a race dogged by retirements the cars proved to be 100% reliable and extremely fast, setting the fastest lap for a front-wheel drive car of 9 minutes 4.71 seconds around the 25-kilometre circuit. Improving on the previous year's overall result, the lead car came 16th out of the approximately 200 starters with the second and third cars coming 51st and 72nd.

- **Not just for vehicles**

Sweden continues to play a leading role in the development of biomethane capacity. The Gothenburg Biomass Gasification project



A Volkswagen Scirocco GT24-CNG on the Nürburgring circuit – the 24-hour race is a supreme test of vehicle performance.

(GoBioGas) will generate electricity and is being built in two stages. The first is due to be operational in 2012 and will deliver approximately 20 MW, with the second stage increasing output to 100 MW by 2016. The objective is for the plant to be as efficient as possible with a projected 65% of the biomass being converted into biogas and an overall plant efficiency of over 90%.

In Japan, Bio Energy Corporation is partnering with Tokyo Gas in a 10-year project to supply biomethane produced from food waste to the city's natural gas grid. This is the first such project in the country. The feedstock is comprised of sewage, food waste and other biomass. Centred at Bio Energy's Jonanjima food recycling facility in Ota-ku, Tokyo, the plant receives 110 tonnes of food residue and waste products and 20 tonnes of waste beverages a day. Following refining, odourisation and calorific value adjustment to match the city's existing gas supply, it is expected that 800,000 m³/year of biomethane will be supplied to the grid, saving 1,830 tonnes/year of CO₂.

In a new development, Hewlett-Packard's sustainable information technology laboratory recently published a report on the possibility of using biogas to power data centres. Higher data transmission rates coupled with the increase in the cost for real estate and electricity near large population centres in the United States are making biogas derived from cow manure an interesting potential source of power. The heat from the computers will be used to assist in powering the biogas digesters which require heat to run.

The increase in the development and utilisation of biogas and biomethane technology allows productive use to be made of waste material, provides people who don't have ready access to clean renewable energy to potentially gain access to it and goes some way to increasing the sustainability of energy supplies on the way to a low- or zero-carbon future.

Adrian Giddings is a Contributing Editor at International Systems & Communications Ltd.

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