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GAZPROM

JSC Gazprom
US $1,100,000,000
Secured Financing Facilities
Sole Underwriter, Bookrunner and Mandated Lead Arranger
Russia, September 2004

NATIONAL JOINT-STOCK COMPANY NAFTOGAZ OF UKRAINE

Naftogaz
US $500,000,000
8.125% Notes due 2009
Sole Lead Manager and Sole Bookrunner
Ukraine, September 2004

GAZPROM

JSC Gazprom
US $1,250,000,000
15,5-year Structured Export Note
Joint Lead Manager and Bookrunner
Russia, July 2004

OAO Rosneft
US $500,000,000
5-year Secured Term Loan Facility
Mandated Lead Arranger
Russia, May 2004

TULLOW OIL

Tullow Oil
US $500,000,000
Public Offer for Energy Africa
Lead Financial Adviser and Joint Acquisition Finance Underwriter, ABN AMRO
Equity Underwriter and Broker, Hoare Govett
United Kingdom, May 2004

StarEnergy

Star Energy
£105,000,000 Initial Public Offering
£58,000,000 Debt Facilities
Nominated Adviser and Sole Bookrunner, ABN AMRO
Broker, Hoare Govett
United Kingdom, April 2004

LNG

Guangdong Dapeng LNG Company Ltd
US $880,000,000
LNG Import Terminal and Trunkline Project
Financial Adviser
China, April 2004

btc

Baku-Tbilisi-Ceyhan
US $3,400,000,000
ECA/MLA Project Financing
Mandated Lead Arranger and Joint Bookrunner
Azerbaijan, February 2004

LUKOIL OIL COMPANY

OAO Lukoil
US $765,000,000
7-year Secured Term Loan Facility
Mandated Lead Arranger
Russia, November 2003

ABN·AMRO

International Cooperation

IGU cooperates with a number of related international organisations and also has contacts with energy-related projects.

● Cooperation with related international organisations

International Energy Agency (IEA)

There is a close cooperation between IEA and IGU with respect to the Special Project on Gas to Power. Workshops are organised in cooperation with IEA. For further information on IEA please refer to www.iea.org.

UNFCCC COP 10

The CC Chairman and the Secretary General in cooperation with the Chairman of PGC A and the Special Project on Sustainability contributed to the 10th session of the Conference of the Parties (COP 10) to the UN Framework Convention on Climate change (UNFCCC). This was held in Buenos Aires between December 6 and 17, 2004. (For more information see http://unfccc.int/cop10/index.html.)

IGRC

The International Gas Research Conference (IGRC) is the world's foremost international forum devoted to the exchange of recent research concerning gas technology. The triennial conference covers the entire gas chain, from wellhead to burner tip. Since starting in 1980 IGRC has had the US gas institutes (first the Gas Research Institute – GRI – and latterly the Gas Technology Institute – GTI) and IGU as main sponsors. Furthermore, a number of national gas entities have supported IGRC as co-sponsors over the years.

IGRC is managed by a Policy Committee with participation from sponsors, a Technical Programme Committee with broad participation of company research departments and institutes, and the Secretariat, while practical organisation was in hands of GRI/GTI up to and including the 2004 event. With GTI no longer able to fulfil this function, the IGRC Policy Committee asked IGU to take charge of the event. IGU has now accepted an offer from Gasunie Engineering and Technology in The Netherlands to assume the secretarial tasks of IGRC.

IGRC has typically alternated between Europe and North America, with the 2004 event taking place in Vancouver, Canada, November 1-4. There were 369 participants and the conference featured 286 papers presented in oral or poster sessions. This IGRC had a small exhibit, which was much-frequented by the conference participants, while a new award was launched.

Vinod Chauhan, Advantica Asset Optimisation Solution Consultant, and co-author Wytze Sloterdijk of NV Nederlandse Gasunie, were awarded the first ever Dan A. Dolenc Award in recognition of their paper "Advances in Interaction Rules for Corrosion Defects in Pipelines". The paper was selected by the IGRC Technical Programme Committee for its innovation, relevance to the gas industry and high scientific quality. It describes the results of a three-year project to develop improved methods to assess the remaining strength of corroded transmission pipelines. The award was presented by Mrs Jean-Marie Dolenc at the closing ceremony of the conference.

● Contacts with energy-related projects

NaturalHy Project

The NaturalHy project, which is the first of its kind in the world, is investigating the barriers to, and the benefits to be gained from, distributing hydrogen by adding it into the extensive existing natural gas grid in Europe.

IGU is represented in the steering committee of this project. It is a highly strategic project and it offers a bridge for the transition to a sustainable energy supply by using the cleanest of fossil fuels:

natural gas. This research project, which has a duration of five years and a budget of €17.3 million, will benefit to the tune of €11 million from the European Commission's sixth R&D framework programme. The project started on May 1, 2004, with a full consortium kick-off meeting in Leiden, The Netherlands.

The physical properties of natural gas and hydrogen are significantly different and this has necessitated research aimed specifically at the safety aspects of transport; distribution; and use of hydrogen/natural gas mixtures; and the possible influences of hydrogen on the pipeline system. Furthermore membrane filters will be developed which will be able to extract hydrogen selectively from the mixture, so that it will be possible to provide, for example, fuel cells directly with hydrogen via the natural gas grid.

Hydrogen is foreseen as playing a key role in a sustainable energy future, because it offers advantages with regard to security of energy supply, reduction of carbon dioxide emissions in line with the requirements of the Kyoto Protocol and improvement of air quality. However, the transition to the hydrogen economy will be lengthy (30-50 years), costly and will require significant research and development. In the transition period natural gas will play an important and strategic role.

The NaturalHy project is a stepping stone to the hydrogen economy, in a practical, cost-effective way. Thirty-nine partners are participating in this extensive project, including gas companies, research institutes and universities throughout Europe. The project is coordinated by Onno Florisson and Rolinda Huizing of Gasunie Research of The Netherlands. Specific information about the ongoing tasks of the project will be made available at www.naturalhy.net.

Stanford University – Baker Institute study

A description of this study into the geopolitics of gas was given in the last progress report (see pages 69-70 of the September 2004 IGU Magazine) and more details can be found at http://pesd.stanford.edu or www.bakerinstitute.org. The final study results have been submitted for review. Theo Ebels of Gas Transport Services of The Netherlands is representing IGU in this study. For more information please contact him (t.f.ebels@gasunie.nl).

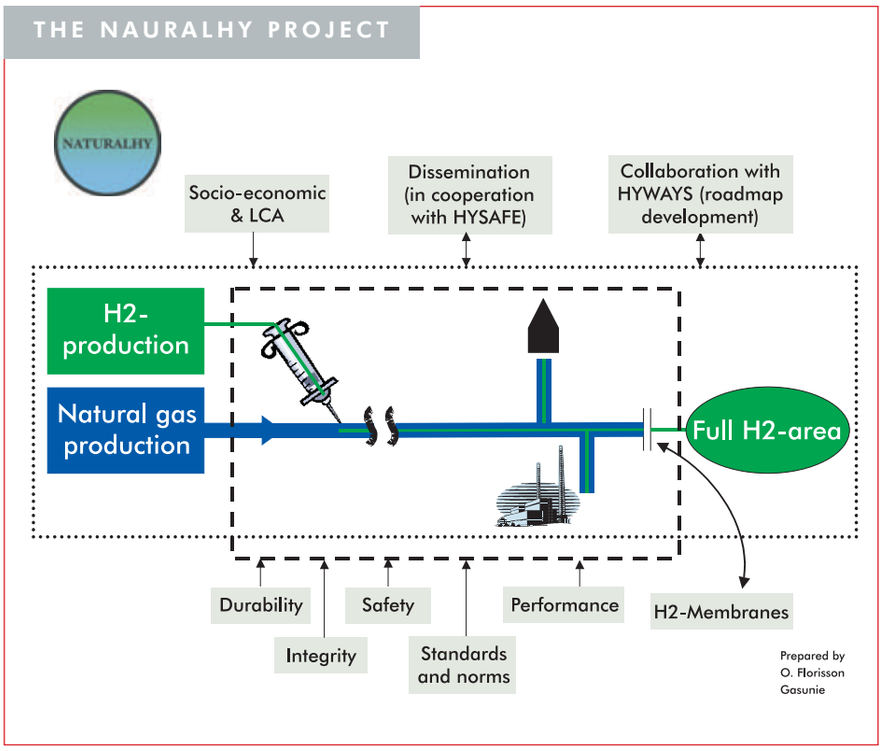


Figure 1. The physical properties of natural gas and hydrogen are significantly different and this has necessitated research aimed specifically at the safety aspects of transport, distribution, use of hydrogen/natural gas mixtures and the possible influences of hydrogen on the pipeline system. Furthermore membrane filters will be developed which will be able to extract hydrogen selectively from the mixture, so that it will be possible to provide, for example, fuel cells directly with hydrogen via the natural gas grid.

Annex

Milestones and deliverables

Progress reports

- 2005 first half year June 1, 2005
- 2005 second half year December 31, 2005
- 2006 first half year May 1, 2006

Papers and reports

- *September 1, 2005*
  Deadline for abstract submission and names of invited speakers
- *October 1, 2005*
  Paper selection ready, authors to be notified
- *February 1, 2006*
  Deadline for paper submission (including invited speakers) and for the submission of the committee reports

Presentations

For each meeting of the CC each Committee has to prepare a 10-minute PowerPoint presentation on the progress of its work. This should be available on the Collaboration Portal one week before the meeting date, together with a short (one A4 page) progress report.

- *October 10, 2005*
  Deadline for Tianjin City meeting
- *March 3, 2006*
  Deadline for Goa meeting

Presentations for the World Gas Conference 2006 must be handed in at the authors' room the day before the session date at the latest.

Addresses

Mr George H. B. Verberg
IGU President
Chairman WGC 2006
P. O. Box 19, 9700 MA Groningen,
The Netherlands
Telephone: +31 50 521 2261
Fax: +31 50 521 1977
E-mail: george.verberg@wgc2006.nl

Mr Bert Panman
IGU Coordination Committee Chairman
Director Special Projects,
N.V. Nederlandse Gasunie,
Gastransport Services
P. O. Box 19, 9700 MA Groningen,
The Netherlands
Telephone: +31 50 521 3284
Fax: +31 50 521 1977
E-mail: bert.panman@wgc2006.nl

Mr Roberto Brandt
IGU Coordination Committee Vice Chairman
CEO, MetroGAS S.A.
G. Aráoz de Lamadrid 1360, 3°
(1267 AAB) Buenos Aires, Argentina
Telephone: +54 11 4309 1400
Fax: +54 11 4309 1447
E-mail: rbrandt@metrogas.com.ar
PA: scowan@metrogas.com.ar

Mr Rob Aptroot
IGU Coordination Committee Secretary
N.V. Nederlandse Gasunie,
Gastransport Services
P. O. Box 19, 9700 MA Groningen,
The Netherlands
Telephone: +31 50 521 3047
Fax: +31 50 521 1977
E-mail: rob.aptroot@wgc2006.nl

Mr Peter K. Storm
IGU Secretary General
P. O. Box 550
c/o DONG A/S
Agern Allé 24-26
DK-2970 Hørsholm, Denmark
Telephone: +45 45 17 13 66
Fax: +45 45 17 19 00
E-mail: pks@dong.dk

Ms Lisbeth Koefoed
IGU Secretariat
P. O. Box 550
c/o DONG A/S
Agern Allé 24-26
DK-2970 Hørsholm, Denmark
Telephone: +45 45 17 12 00
Fax: +45 45 17 19 00
E-mail: secr.igu@dong.dk

Dr Colin D. Lyle
Working Committee 1 Chairman
Director of European Policy
Centrica Energy
Millstream, Maidenhead Road,
Windsor, Berkshire SL4 5GD,
United Kingdom
Telephone: +44 1753 431172
Fax: +44 1753 431040
E-mail: colin.lyle@centrica.co.uk

Dr Sergei A. Khan
Working Committee 2 Chairman
Head of UGS Direction OAO,
GAZPROM
65, Novocheremushkinskaya str.,
Moscow 117418
Russia
Telephone: +7 095 719 2954
Fax: +7 095 719 4761
E-mail: S.Khan@adm.gazprom.ru

Mr Juan A. Diez de Ulzurrun
Working Committee 3 Chairman
General Director Iberdrola
c/Gardoqui 8
48008 Bilbao, Spain
Telephone: +34 944 663844

Fax: +34 944 663174
E-mail: ja.ulzurrun@iberdrola .es

Mr Peter A. Cistaro
Working Committee 4 Chairman
Vice President, Gas Delivery Public Service Electric & Gas Co
80 Park Plaza, P. O. Box 570, T-14
Newark, New Jersey 07101, USA
Telephone: +1 973 430 5100
Fax: +1 973 430 7826
E-mail: peter.cistaro@pseg.com

Mr Marc Florette
Working Committee 5 Chairman
R&D Vice President , Gaz de France
361, avenue du President Wilson, BP 33 93211, St-Denis la Plaine Cedex, France
Telephone: +33 1 49 22 50 59
Fax: +33 1 49 22 49 49
E-mail: marc.florette@gazdefrance.com

Mr Daniël Arias
Programme Committee A Chairman
HSE Manager,
Pan American Energy LLC
Leandro N. Alem 1180, Piso 11,
C1001AAT Buenos Aires, Argentina
Telephone: +54 11 4310 4394
Fax: +54 11 4510 3815
E-mail: darias@pan-energy.com

Dr Klaus-Robert Kabelitz
Programme Committee B Chairman
E.ON Ruhrgas AG
Huttropstraße 60
45138 Essen, Germany
Telephone: +49 201 1843440
Fax: +49 201 1843824
E-mail: klaus-robert.kabelitz@ruhrgas.com

Mr Camillo Michele Gloria
Programme Committee C Chairman
Senior Vice President International Development and Trading
Eni SpA Gas & Power Division
Piazza Vanoni 1, 20097 S.Donato Milanese, Italy
Telephone: +39 02 5203 1628
Fax: +39 02 5205 1293
E-mail: camillo_michele.gloria @eni.it

Dr Chawki Mohamed Rahal
Programme Committee D Chairman
Director General, Sonatrach Petroleum Corporation
5, Princes Gate, London SW7 1QJ, United Kingdom
Telephone: +44 20 7823 8030
Fax: +44 20 7589 9894
E-mail: pgcd@sonatrach.co.uk

Mr Roy Bilbé
Chairman of Task Force R&D
N.V. Nederlandse Gasunie
Energieweg 17, P.O. Box 19,
9700 MA, Groningen,
The Netherlands.
Telephone: +31 50 521 2547
Fax: +31 50 521 1946
E-mail: r.m.bilbe@gasunie.nl

Mrs Véronique Durand-Charlot
Chairwoman of Task Force ICT
Deputy Vice President Procurement & IT, Gaz de France
Courcellot 1 Building 2, rue Curnonsky, 75017 Paris, France
Telephone: +33 1 47 54 23 66
Fax: +33 1 47 54 25 56
E-mail: veronique.durand-charlot@gazdefrance.com

Mr Rene Snijder
Project Leader Special Project Regulation
N.V. Nederlandse Gasunie
P. O. Box 19, 9700 MA Groningen,
The Netherlands
Telephone: +31 50 521 2300
Fax: +31 50 521 1943
E-mail: r.snijder@gasunie.nl

Mr Ulco Vermeulen
Project Leader Special Project Sustainability
N.V. Nederlandse Gasunie
P. O. Box 19, 9700 MA Groningen,
The Netherlands
Telephone: +31 50 521 2902
Fax: +31 50 521 1941
E-mail: u.vermeulen@gasunie.nl

Mr Dick de Jong
Project Adviser Special Project Gas to Power
Fellow of the Clingendael Institute Energy Programme
Clingendael 7a, P. O. Box 93080,
2509 AB Den Haag,
The Netherlands.
Telephone: +31 70 324 7724
Fax: +31 70 374 6688
E-mail: dj.dejong@wxs.nl

Mr Robert C. A. Doets
Chairman of NOC – WGC 2006
Secretary General of the KVGN
P. O. Box 20051,
7302 HB Apeldoorn,
The Netherlands
Telephone:+31 26 356 6345
Fax: +31 26 356 6346
E-mail: secr.kvgn@kvgn.nl

Mrs Mariska van der Veen
Project Leader of WGC 2006
Eurocongres Conference Management
Jan van Goyenkade 11, 1075 HP Amsterdam,
The Netherlands
Telephone: +31 20 679 3411
Fax: +31 20 673 7306
E-mail: veen@eurocongres.com

Pipeline Integrity – Meeting the Challenges

By Tim Sylvester, Vice President Pipelines, Shell Global Solutions (US) Inc.

Pipeline operators around the world are facing several challenges, including ageing pipelines. It is estimated that over 25% of pipelines are more than 50 years old and another 25% are more than 25 years old. As gas transmission becomes more widespread, many long-distance, cross-border and multi-terrain lines are being planned.

As the emphasis on health, safety, environment and security issues increases, pipeline operators will need to be focused from the initial feasibility stage right through to operations. A major goal for these companies is managing the integrity of pipelines for incident-free operation. Achieving this will allow them to continue safe and reliable natural gas supply to their customers without adversely affecting people or the environment.

Shell Global Solutions is helping its pipeline customers around the world to achieve design and operational standards consistent with new regimes of regulations and behavioural expectations. Such challenges are applicable in every stage of the life cycle of a pipeline – from feasibility to de-commissioning. Here, we use as an example some of our work from the USA to show how our services are helping gas transmission pipeline operators to cope with new Federal regulations that require them to develop integrity-management programmes for high consequence areas (HCA).

Pipeline operators around the world are facing several challenges.

The USA is spanned by approximately 325,000 miles of gas transmission pipelines, half of which are estimated to be over 50 years old and many of which cross populated or environmentally sensitive areas.

The gas transmission industry has proven to be relatively safe, although a few high-profile pipeline failures have heightened public awareness of, and focused attention on, pipeline integrity. The regulating body in the USA – the Department of Transportation's Office of Pipeline Safety (OPS) – has introduced stringent new rules (based around ASME B31.8S) stipulating that gas transmission pipeline companies must have integrity management programmes for HCAs. These programmes will help not only to assure safety, but also to extend the life of ageing assets and protect the investments made in new ones.

Integrity management programmes provide the information that an operator needs to help allocate resources for the appropriate incident prevention, detection and mitigating actions necessary for improving pipeline safety and security of supply. However, compliance with the new rules can place considerable strain on both financial and human resources.

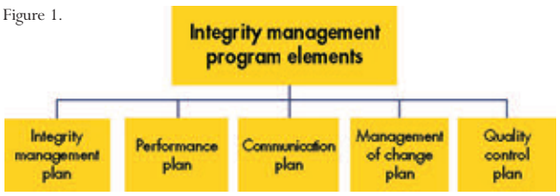
Compliance is not just a case of completing a checklist. An integrity management programme should be, according to ASME B31.8S, continuously evolving and flexible. It must be periodically evaluated and then modified to accommodate changes, for example, new data about the pipeline. The new regulations not only require companies to have an integrity management programme, but also to show, among other things, how their programme will change. Thus, compliance is a major undertaking.

New US regulations

US gas transmission pipeline companies are obliged, under the new regulations, to develop an integrity management programme that examines and verifies the structural soundness of pipelines. The rules particularly apply to those pipelines that cross HCAs – areas with 20 or more buildings intended for human occupancy, identified sites where people congregate such as beaches, playgrounds and sports facilities, or environmentally sensitive areas.

The regulations specify the elements that must be included in an integrity-management programme. These are based on the five plans documented in ASME B31.8S (*Figure 1*):

Figure 1.



- ***Integrity management plan.*** This plan is developed from the integrity management process (*Figure 2*). This process identifies threats to pipeline segments; gathers, reviews and integrates data on the threats and the pipeline segments; and then uses these data to conduct a risk assessment, which considers the likelihood and consequence of potential pipeline failures. The risk assessment helps operators to prioritise pipeline segments for integrity assessment, which might use in-line inspection, pressure testing, direct assessment or other methods. The next step in the process is a response to the integrity assessment and may involve mitigation measures – repair and prevention – and the setting of inspection intervals. Having completed an initial integrity assessment, the operator will have new information available about the pipeline. This should be integrated into the existing database and used to periodically reassess the risk and restart the integrity management process (*Figure 2*).
- ***Performance plan.*** Operators are required to collect information on the performance of their integrity management process and use it to evaluate the success of the integrity management techniques, the pipeline repair activities and the risk-control activities. Operators are also asked to evaluate the management systems that support the integrity management decisions and the application of new technologies.
- ***Communications plan.*** Operators must also develop and implement a plan for effective communication with their employees, the public, the emergency services and official organisations.
- ***Management-of-change plan.*** A systematic process must be developed to confirm that, before implementation, changes to the design, operation or maintenance of a pipeline are evaluated for risk. Changes to the environment in which the pipeline operates must also be evaluated.
- ***Quality-control plan.*** A plan must be developed that evaluates the integrity management programme for quality-control purposes.

Putting the five plans into action is likely to require some transformation in the way gas transmission pipeline operators work. For example, once the threats to a pipeline have been identified, the data collected and integrated, a risk assessment performed and a prioritised integrity assessment made, the necessary mitigation measures may result in a de-rating of that pipeline. This will now require a more structured process that informs everyone associated with the operation of that pipeline that it cannot be run at its former pressure and what the new pressure is. The risk of the change must also be evaluated in line with the new management-of-change plan.

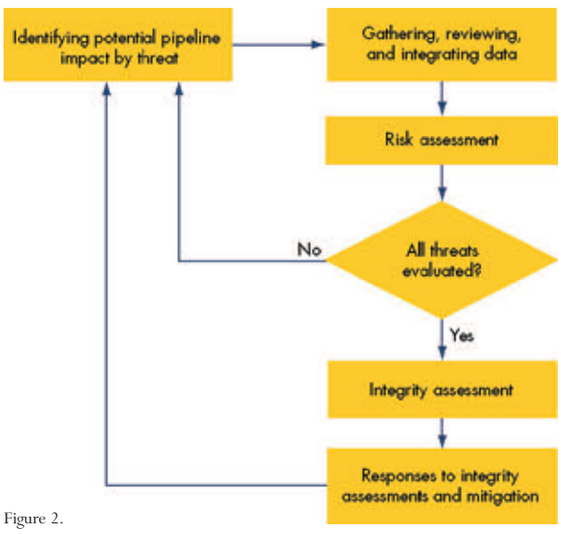


Figure 2.

Implications

Gas transmission pipeline companies have embraced the challenges raised by the new regulations. However, meeting this new standard – developing a comprehensive integrity management programme – cannot be done instantly and may require considerable resources.

In addition to providing people to work on the detailed plans, operators have to inspect the structural soundness of pipelines in HCAs – the baseline integrity assessment. They must decide whether to modify those pipelines that are not currently piggable (by installing facilities for launching and receiving smart pigs for in-line inspection) or use direct assessment methods. The former involves capital investment and interruption to production, and the latter is a relatively expensive assessment method that does not have the reliability of in-line inspection methods. In fact, the industry standard ASME B31.8S states that operators should evaluate and implement new technology as it becomes proven and practical, thus placing pressure on them to modify pipelines to accommodate smart pigs.

Systems must also be developed to manage the huge volume of data generated from such baseline inspections. Operators must have confidence that wall thickness profiles acquired from smart pig data, and held in a database, can be related to particular points on a pipeline so that if issues are identified these can be resolved.

The whole compliance exercise is resource intensive in terms of people, time and costs. It is no surprise, therefore, that companies are seeking expert and objective help. Although many companies are making excellent progress internally with compliance, having an objective assessment of an integrity management programme from an outside but experienced organisation can be invaluable. Shell Global Solutions*, with its extensive experience of pipeline integrity management around the world, is in an excellent position to offer support.

A view from outside

Shell Global Solutions is helping pipeline companies to comply with the Federal regulations by performing gap analysis, identifying opportunities and setting priorities, although the solutions the organisation offers are specific to each company's specific assets.

Northern Natural Gas, Omaha, Nebraska, USA, is a company that is meeting the safety challenges presented by the new regulations. It has a history of applying thorough and precise integrity management programmes, but wanted an objective third-party assessment of its compliance plan for the new regulations so that it would meet the safety challenge. Shell Global Solutions provided that objective review.

Gas is gathered by Northern Natural Gas from the mid-continental production basin, including the Permian, Rocky Mountain and Canadian basins. This gas is then transmitted through an extensive network of pipelines to retail customers in Nebraska, Iowa, South Dakota, Minnesota, Wisconsin and the upper peninsula of Michigan.

A team from Shell Global Solutions met staff from Northern Natural Gas to provide an outside view and a broad industry perspective on the five plans that were being developed to comply with the new rules. The team included technologists and an information technology professional, as data management is a major part of the exercise.

The team gathered information, performed a gap analysis in a collaborative effort through interviews with key personnel, and then identified the strengths of the plans and opportunities for their improvement. Recommendations were made for implementing the improvements (*Figure 3*). Northern Natural Gas is already benefiting from the review, particularly from improvements to the data-management and integration systems.

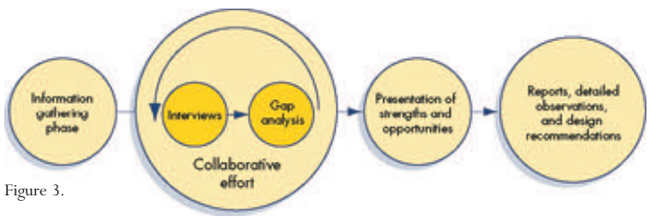


Figure 3.

Operational experience combined with business sense

The Royal Dutch/Shell Group has operating units across the world that install, run and maintain pipelines. In fact, the Shell Group operates tens of thousands of miles of pipeline. Shell Global Solutions – the Group's technology and business consultancy network – has expert employees who have experienced numerous pipeline integrity issues, many of them having worked in pipeline companies for their entire careers. But Shell Global Solutions' ability to help companies develop pipeline integrity programmes does not just come from this operational experience; it also comes from the business sense that its experts have developed through helping customers to run their businesses – from conception through operations and decommissioning. The organisation offers solutions and recommendations that are industry tested, realistic and designed to be achievable.

A global standard

While the new regulations only apply in the USA, the industry standard (ASME B31.8S) on which they are based is universally accepted. Whether companies operate in Africa, America, Europe, the Far East, the Middle East or elsewhere, they should have a programme for managing the integrity of their assets for the safety and protection of their investments, regardless of the requirements stipulated by regulators. An objective third-party assessment by a consultant who can call on a vast project execution and operational experience can be an invaluable part in the development of such a programme.

**Shell Global Solutions is a network of independent technology companies in the Royal Dutch/Shell Group. In this material the expression "Shell Global Solutions" is sometimes used for convenience where reference is made to these companies in general, or where no useful purpose is served by identifying a particular company.*

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email us at **shellglobalsolutions@shell.com**
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FEATURES

This issue's feature section contains an introduction to the President's Wise Persons Group, an overview of IGU's work on greenhouse gas emissions, articles on LNG and GTL, a report on the Ghislenghien pipeline accident, a focus on the R&D Task Force, a preview of ICT2005, and reports on the experience of an Associate Member and a project to preserve the gas industry's heritage. We round up with a description of the publications and documents available from IGU, the events calendar and a new opinion page.

The President's Wise Persons Group

By Mark Blacklock

The European Union had its "Comité des Sages" and now IGU has the Wise Persons Group. It is an innovation of the Dutch Presidency and George Verberg says he is pleased with the results so far.

"We deemed it appropriate within IGU to have the Presidency advised by an outside group of energy experts from around the world," he explains. "They are being asked to think about major energy issues, particularly in the natural gas sector, and to give their general viewpoint. It's about broad brush strokes rather than the nitty-gritty and about being thought-provoking rather than drawing definite conclusions. The idea is to start a good discussion among the IGU membership."

The four members of the group are Professor Dr Coby van der Linde, Director of the Clingendael International Energy Programme (CIEP), The Netherlands; Mr Tim Eggar, Head of Country Coverage for ABN Amro Bank and former UK Energy Minister, United Kingdom; Mr Yoshihiro Sakamoto, President of Arabian Oil Company Holdings, Japan; and Dr Daniel Yergin, Chairman of Cambridge Energy Research Associates, United States. They confer and take it in turns to make formal presentations to IGU meetings.

Professor Dr Coby van der Linde started the cycle by addressing the Council meeting in Oslo in September 2004 during the session on "Energy Supply Security for Europe and its Impact on the World Gas Market". Her presentation drew on a study[1] that CIEP carried out for the European Commission analysing EU energy supply security in a broader context than the traditional, focused assessment of geopolitical risks in major producing regions. The new perspective brings in analysis of the energy strategies of other consuming countries/regions and thus places security of supply in the dynamic context of geopolitics and geo-economics. The CIEP study makes clear that the EU should develop its own strategy as an integral part of external policy-making but, at the same time, should also invest in dialogues with other net energy importers, such as the US and China, and exporters, such as the Gulf countries and Russia.

Professor Dr Coby van der Linde.

At Oslo Professor van der Linde highlighted the fact that in its day-to-day focus on economic and technical issues, the gas industry can be distracted from the wider geopolitical context. The fact that Europe is becoming increasingly dependent on gas imports as domestic production matures arouses fears that these supplies could be cut off as easily as oil supplies have been in the past. The industry, she said, needs to engage with decision-makers to explain that gas is different, that the need for major investments in LNG facilities and pipelines means that gas suppliers and consumers have long-term relationships with a less unequal balance of power. Notwithstanding this, however, she also highlighted the value of diversity of supply in risk management.

1 This report can be downloaded from the CIEP website at www.clingendael.nl/ciep, by clicking on publications and then selecting the report under the heading "CIEP Studies".

Mr Tim Eggar.

Mr Yoshihiro Sakamoto.

Dr Daniel Yergin.

Internationalisation of the gas market

"I was greatly honoured to be invited to join the Wise Persons Group," says Professor van der Linde. "The internationalisation of the gas market also brings geopolitical matters to the sector. For the gas sector it is important to point out the differences with the international oil sector, but also to take important lessons from the development of international oil relations, where producer and consumer countries and companies have sometimes found themselves at opposing sides of the discussion. It is important for the gas sector to communicate its specific nature and interests to realise its great potential as a secure and relatively clean fuel. I hope that through the Wise Persons Group I can assist in this process and that at the 2006 World Gas Conference these new developments in the sector can be addressed by IGU."

Next up was Mr Tim Eggar, who gave a presentation at the IGU-sponsored International Gas Research Conference (IGRC) in Vancouver, Canada, in November 2004, and is also attending this month's Executive Committee meeting in Warsaw, Poland.

"I am delighted to be part of this group," says Mr Eggar. "I delivered a keynote address at IGRC-2004 where I tried to bring together the aspects the research community has to think about in connection with major energy projects." Mr Eggar's presentation entitled "The Geopolitics of Gas: Threat or Opportunity for the IGRC Community" looked at the complex mix of environmental, political, technical and economic issues that need to be considered when developing new gas supply projects. Among other points he took up Professor van der Linde's theme of the importance of engaging a wide audience and highlighted the role of public relations. "Going forward, I will be introducing a discussion at Warsaw on privatisation in the gas industry drawing on the UK experience."

Following this focus on Europe, Mr Sakamoto and Dr Yergin have been invited to this year's Council meeting in Tianjin City, China in October to give their views from the Asia-Pacific and American perspectives. Their presentations will be covered in future issues of the IGU Magazine.

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

The Natural Gas of Petrobras

Natural gas accounts for 7.5% of Brazil's energy matrix, and Petrobras is wagering on steady growth in this sector, which should reach a 15.0% share of Brazil's energy grid in 2015. This feeling of optimism is due mainly to the discovery of 78 billion m^3 of natural gas in the Santos Basin – which have already been included in the proven reserves – and a further 341 billion m^3 in the assessment phase. It is expected that Brazil's current proven reserves of 316 billion m^3 will reach 657 m^3, doubling supplies of this fuel over the next 10 years.

A detailed study by the Petrobras Gas & Energy Business Area underpinned the Natural Gas Mass Use Programme, which is guiding Petrobras in its efforts to expand Brazil's natural gas market in its various segments: industrial, commercial, thermo-power, vehicles, co-generation and residential. In 2004, natural gas played a leading role in the Petrobras Strategic Plan, selecting as its Corporate Strategy: head up the oil, NATURAL GAS and Related Products Markets in Latin America, operating as an integrated energy enterprise, including selective expansion of the petrochemical segment and international activities. The Gas & Energy Business Area will allocate investments of US$6.1 billion between 2004 and 2010. Of this amount, US$3.9 billion will be earmarked for expanding the gas pipeline network, which is the main project in this area.

These investments and the expansion of natural gas consumption may cause economic, social and environmental impacts. The Natural Gas Mass Use Programme estimates that the natural gas business will have an average impact of 0.6% of Brazil's Gross Domestic Product (GDP) in 2015, and could reach US$3.3 to US$5.7 billion in 2006. This Programme will benefit society through opening up thousands of direct jobs. Over the long term, estimates indicate that this may reach 200,000 permanent new work-posts. The benefits to the environment will come from lower emissions of the main pollutive gases, with less greenhouse effect, reduced by some 6,000,000 tons a year, mainly carbon dioxide.

Investments

The joint efforts of Petrobras, the distribution and shipping companies, and universities and research centres have given rise to the RedeGasEnergia Gas & Energy Network, which is striving to grow the natural gas market. Its technological development and research projects portfolio includes more than 100 projects scattered all over Brazil, absorbing total investments of R$61 million in 2004. Applications in the automotive, energy efficiency, co-generation, power distribution and industrial applications segments, as well as commercial and residential uses, are just some of its areas of operation.

Over the next two years, some US$3.9 billion is being allocated for investments in infra-structure. Approximately 4000 kilometres of gas pipelines will be built, linking major gas production centres with the integrated network. Wherever new offshore gas reserves are discovered, the shipping network will be ready to serve the market.

Petrobras envisions a natural gas scenario where consumers will become increasingly more demanding, seeking quality and technology while giving preference to cleaner energy sources. Moreover, natural gas use will be stepped up in all segments, with rapid expansion of the vehicular (compressed) natural gas (VNG/CNG) market. In fact, excellent opportunities are opening up, paving the way for Petrobras to invest in expanding Brazil's natural gas market.

It's not always possible to show you natural gas.

As any clean energy, it doesn't like to appear.

There is nothing more natural than for Petrobras to invest in the energy of the 21st Century. Natural gas is a clean energy, economic and efficient, that you don't see in the environment but you feel in the benefits. Petrobras transports this energy by the largest gas pipeline network in Latin America. And by 2010, it will have invested more than US$ 3 billion in expanding this network. With the recent discoveries in the Santos and Espírito Santo Basins, Petrobras will also be responsible for tripling of the offer of natural gas to the domestic market. Consequently it is fundamental to create a cooperative environment, where Petrobras, other companies and society can work together throughout the productive chain of natural gas in Brazil and the other countries of the Southern Cone. Petrobras. Bringing the energy of the future, ever closer to the present.

BR PETROBRAS

IGU and Greenhouse Gas Emissions

By Rob Aptroot and Tjerk Veenstra

Sustainable development has played an important role in the policies adopted and contributions made by IGU over the years. In the light of the latest insights and the worldwide debate on greenhouse gas emissions, we would like to inform you about the status of the discussions in IGU with respect to this issue.

Mission statement

IGU adopted its Vision, Mission and Objectives some time ago without explicitly mentioning greenhouse gases. They are implicit, though, in the way the statement is formulated. In its Vision IGU recognises "that natural gas has an important part to play in satisfying the global need for an environment-friendly energy source…", while as part of its Mission"…IGU will help optimise the economics of the entire gas chain, while emphasising sound environmental performance, safety and reliability".

At the 22nd WGC there were several presentations mentioning greenhouse gases.

Guiding Principles for Sustainable Development

In October 2003 IGU published a brochure on "Guiding Principles for Sustainable Development". This includes among other things a statement (page 5) that explicitly involves the gas industry's attitude towards greenhouse gases: "The gas industry shall encourage clean and efficient gas utilisation to improve local conditions and contribute to a reduction of greenhouse gas emissions".

The 2003 World Gas Conference

"Catalysing an Eco-responsible Future" was the theme for the 22nd WGC, which was held in Tokyo, Japan in June 2003. During the Conference there were several presentations mentioning greenhouse gases.

Sir Philip Watt, Chairman of Royal Dutch/Shell at the time, explicitly mentioned the role natural gas will play in the future, preventing global warming, and the potential it has to develop into the core energy source of the next generation.

The special address on "Energy strategy beyond 2010: how to mitigate global warming" of Yoichi Kaya, Director General of Japan's Research Institute of Innovative Technology for the Earth (RITE), concluded: "One long-term strategy to combat global warming is to set unit output emissions targets for individual industries….".

Claude Mandil, Executive Director of the International Energy Agency (IEA), concluded in his special address on "The role of natural gas in global energy markets" that "CO_2 storage

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technologies will also be required".

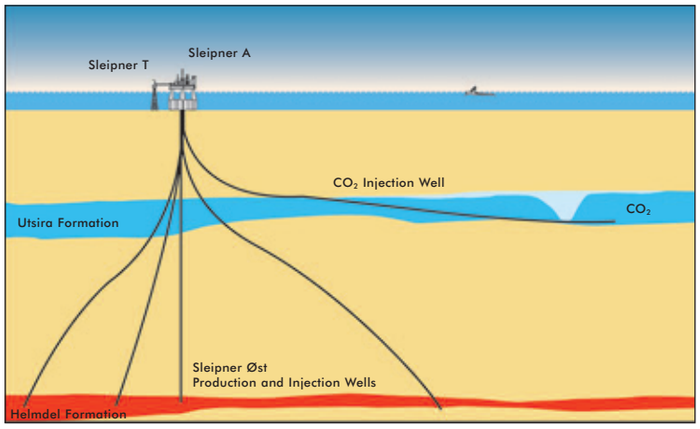
Howard J. Herzog of the Massachusetts Institute of Technology mentioned during the Strategic Round-table on Global Energy Scenarios that "the development of carbon sequestration technology would put natural gas and coal in competition with each other in the future".

In the Strategic Round-table on Perspectives and Challenges of Technologies for a Methane Age, Professor Dr Nebojša Nakićenović (International Institute for Applied Systems Analysis – IIASA – and the Vienna University of Technology) concluded: "Methane can also serve as a bridging energy to a 'hydrogen age' and a sustainable world, by combining with carbon capture and storage technologies". In the same round table it was stated by Dr James A. Edmonds (Pacific Northwest National Laboratory, USA) that "for natural gas to play a significant role over the long term, gas resources must be developed stably and economically, together with technologies for the capture and storage of carbon dioxide..".

The paper of Wayne Soper Chairman of Working Committee 8 (WOC 8) on Sustainability and the report of his Committee (Study Group 8.1 in particular) made an important contribution to updating the gas industry on the topic of greenhouse gas emissions and the strategy the gas industry should adopt in this respect. Moreover, the Japanese Special Project on Sustainable Urban Systems Design was entirely devoted to the issue of sustainability. The results of this project gave an interesting view on how the world could look like when we implement measures that lead to an entirely sustainable urban system design, which includes abandoning greenhouse gas emissions for energy production altogether.

● The 2003-2006 Triennium and greenhouse gases

The slogan adopted for this Triennium is: "Gas: powers the people, preserves the world, promoted by IGU", which reflects the significant contribution of gas to a clean environment. The discussion on the work to be done in the 2003-2006 Triennium started in early 2003 and resulted in three Strategic Guidelines, one of which is: "IGU will promote natural gas as the fuel of choice preceding a sustainable energy system". Part of the text of this guideline states: "Since natural gas produces the smallest amount of CO_2 per kWh of all the fossil fuels, replacing coal and oil by natural gas where economically possible, notably in generating electricity, is of prime importance. In the long term decrease of CO_2 emissions can be realised if CO_2 sequestration is further developed....".



Commercial-scale carbon sequestration dates back to 1996, when it was inaugurated at Sleipner in the Norwegian sector of the North Sea. CO_2 is injected into the Utsira formation, a thick saltwater-bearing sandstone at a depth of between 800 and 1000 metres below the sea bed.

The Triennial Work Programme based on the three guidelines mentions CO_2 sequestration at several points:

- (Page 18) Working Committee 2 on Underground Storage: "The task of Working Committee 2 is to provide information on the state-of-the-art technology of underground storage and possible progress. Underground storage plays an important role in the gas chain in balancing supply and demand. It could also play an important role in the future for CO_2 sequestration."

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- (Page 26) Working Committee 5, Study Group on Industrial Utilisation: "The issues related to hydrogen are mainly confined to specific industrial furnaces and components like turbine combustors, but would progressively concern hydrogen production and CO_2 sequestration."
- (Page 28) Programme Committee A on Sustainability (PGC A): "Environmental aspects: a transition from an energy system presently dominated by fossil fuels to a more sustainable system by production of renewable energy from the sun, wind or biomass, and by climate-neutral new fossil technology. Natural gas plays an important role as fuel of choice in this transition. To take into account the developments of H_2 technology and CO_2 sequestration." In the course of its work in this Triennium PGC A, under Chairman Daniel Arias, has formulated for Study Group A2 a work programme based on the recommendations of the final report of WOC 8.
- (Page 48) Special Project on Sustainability: "The work will be carried out with three objectives: Disseminate the vision, Make knowledge available and accessible, Demonstrate and promote successful developments."

During the Triennium several presentations have been given by our President George Verberg on behalf of IGU mentioning the important role of natural gas as a fuel of choice (see the IGU website www.igu.org).

At the ninth session of the Conference of the Parties (COP 9) to the UN Framework Convention on Climate Change, which was held in Milan in December 2003, IGU organised a special event to promote the use of gas as an alternative automotive fuel and for distributed electricity generation. There was also a special event at COP 10 in Buenos Aires in December 2004 (see below).

19th WEC Congress

IGU works closely with the other global energy organisations and sent a high-level delegation to the World Energy Council's 19th World Energy Congress, which was held in Sydney, Australia in September 2004.

One of the conclusions of WEC 19 was: "Climate change is a serious global concern, calling for changes in consumer behaviour, but offering potential win-win opportunities. These include increased transfer of efficient technologies from industrialised to developing countries and incentives to investment through emerging voluntary or regulated emissions trading or other mechanisms."

RIGHT
Figure 1.

PREDICTIONS OF ENERGY NEEDS

World Energy Consumption EJ	*2000*	*2025*	*2040*	*2050*	*2100*
Nakićenović e.a	400	600	800	1200	
Shell	400	640		850	N/A
IEA	400	647*		N/A	N/A
WEC	400		600-1050		890-1900

N/A = not available

*interpolation 2020-2030

Sources: Nebojša Nakićenović, Global Natural Gas Perspectives, IIASA, IGU, 2000; Exploring the Future, Energy Needs, Choices and Possibilities, Scenarios to 2050, Global Business Environment, Shell International, 2001; IEA World Energy Outlook 2004; Proceedings of the 19th World Energy Congress.

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Gas & Beyond

Predictions of energy needs

Based on predictions from several sources (see *Figure 1*) it is assumed that the use of fossil fuels will be continued at least to the end of this century. It is expected that the total amount of energy needed by the world population will increase from 400 EJ (Exa Joules, 10^{18} Joules) now to 1200 EJ by the end of the century, with a large spread in predictions depending on the scenario used.

Without any CO_2 storage this would result in annual CO_2 emissions of 37 Gton by 2025 and almost double that amount by 2100. If the people of the world want to keep the CO_2 concentration in the atmosphere below 550 ppm as proposed by IPCC, we should aim for emissions of 12 Gton by 2100, a tremendous task for the fossil fuel industry.

Cost of CO_2 capture and storage

If CO_2 capture and storage is inevitable in the long run what will it cost? Of course it is too early to tell with great precision, since it is dependent on future developments and local circumstances. In an IGU review note on CO_2 capture and storage a figure is quoted of $50 per tonne avoided CO_2 emission for electricity power generation. It is estimated that this increases the production cost of gas-fired power generation per kWh by about $0.02 ($0.04 for coal-fired power generation). This compares to an average price of electricity for industry of $0.07 or $0.125 for households[1]. Given the spread in electricity prices the increase for gas-fired power generation due to carbon capture and storage would vary from 13% to 163% for industry and from 7% to 63% for households.

1 The figure is from the IEA's Key World Energy Statistics and is based on an average of 26 countries.

IGU workshop on greenhouse gas emissions

In a joint workshop Working Committees 1 and 2 and Programme Committee A discussed a draft vision paper for IGU on the natural gas industry and greenhouse gases. This draft vision paper lists steps to be taken by the gas industry in the light of global warming based on the three-step approach to meeting our energy requirements known as *Trias Energetica:*

- Reduction of energy use and promotion of energy efficiency;
- The use of renewable energy; and
- Clean fossil techniques.

It is proposed that the steps the gas industry should take in the future are in order of proper timing:

- Intensive promotion of energy conservation and optimal use of energy;
- Development and introduction of highly efficient gas utilisation;
- Developing the use of CO_2 for enhanced oil recovery (EOR);
- Future reduction of methane emissions in the gas chain;
- Introduction of decentralised energy systems;
- Promoting a fuel switch where natural gas has a great advantage; and
- Carbon capture, chemical conversion and storage.

In the discussion of the vision paper several points were raised: Have an open mind for regional differences and different market development phases, when proposing steps for greenhouse gas emission mitigation, to be taken or promoted by the gas industry. This is certainly the case when further economic development is highly dependent on the increase of energy supply. Especially developing markets should have the most modern and efficient techniques available to them, to keep their energy intensities and energy costs at an acceptable level.

In general the gas industry has a credibility problem at some levels and should be able to explain better the steps taken already and the reasons why. A difficult point in this respect is that although the carbon intensity is lower than other fossil fuels, natural gas from geological formations is still a fossil fuel and, while currently abundant, is ultimately a limited energy resource.

It seems inevitable that CO_2 capture (either pre- or post-combustion) and storage will be necessary to be able to use fossil fuels in the long run. Joining forces, on CO_2 capture and storage technology, with the coal industry that faces the same problem might be a good strategy for the gas industry.

It is expected that based on the present regulation situation there is no economic incentive for the gas industry to develop CO_2 storage any further. The present European initiative on emission trading may have some effect on increasing efficiency in power plants and large industries. Joint Implementation projects and the Clean Development Mechanism based on the Kyoto Protocol will also have influence in this respect.

● Further steps from IGU

Professors Catrinus Jepma from the State University of Groningen and Nebojša Nakićenović from IIASA and the Vienna University of Technology have been invited by IGU to prepare a paper[2] addressing these items. The overall view on the subject was presented and discussed in an IGU-sponsored special event at COP 10 in Buenos Aires in December 2004, and the final version will be published later this year. Based on this paper and further discussions, for instance during the planned IGU workshop at IIASA in mid-2005, IGU will prepare a vision paper to be presented at the 23rd World Gas Conference in Amsterdam, June 5-9, 2006.

Rob Aptroot is the Secretary of the IGU Coordination Committee and Tjerk Veenstra is a member of Programme Committee A on Sustainability.

2 Catrinus J. Jepma, University of Groningen, Amsterdam, The Netherlands and Nebojša Nakićenović, IIASA, Vienna University of Technology, Austria, "Future role of natural gas and strategic impact for IGU" (draft), EDI/IGU, Groningen, 2004.

Abu Dhabi Hosts GASTECH 2006

The largest international gas conference and exhibition, GASTECH, which Abu Dhabi, the federal capital city of the United Arab Emirates and capital of the Emirate of Abu Dhabi, will host in 2006, will attract the world's major LNG and LPG producers and exporters looking for opportunities to promote their businesses.

The United Arab Emirates (UAE), which is a federal state with a population of about 2.8 million, comprises seven Emirates: Abu Dhabi, Dubai, Sharjah, Umm Al Quwain, Ajman, Ras Al Khaimah and Fujairah. It is located along the shores of the lower Arabian Gulf and extends across to the Indian Ocean.

With proven oil reserves of 97.8 billion barrels, the United Arab Emirates ranks fourth in the world, and its proven gas reserves of 214 trillion cubic feet qualify it to be fifth in the world. Since oil production began in 1962, the UAE has witnessed tremendous growth and development. Oil and gas revenues were used for the development and prosperity of the country, but the UAE is very keen to develop non-oil industries as well. In Dubai's Jebel Ali Free Zone, the biggest free zone in the region, about 1800 multinational companies have already started operation, and the number is increasing.

Giant gas projects, such as the Das Gas Liquefaction Plant and the Ruwais Gas Processing plant, have for long earned Abu Dhabi its distinguished reputation as the pioneer of the gas liquefaction industry in the Gulf region. Thanks to the invaluable experience that has accumulated over the years, and the prudent guidance and supervision of the Supreme Petroleum Council which reflect the Government of Abu Dhabi's strategies, the gas industries in Abu Dhabi have achieved a remarkable level of growth and development, comparable to the highest in the rest of the world. Abu Dhabi National Oil Company (ADNOC), which has spearheaded the gas industry development in the Emirate, is determined to make GASTECH 2006 the most successful event in the 2006 international gas industry calendar.

Abu Dhabi's gas industry outlook

In the last decade, Abu Dhabi gas processing capacity has increased to more than 5 billion standard cubic feet per day (bscfd). With a capital investment of over $5 billion it will increase to about 7 bscfd by 2008, while LPG production will rise to about 16 million tonnes per annum (mtpa), making Abu Dhabi the world's largest net exporter of LPG.

ADGAS pioneered the production and export of LNG from the Arabian Gulf, back in 1977. It was established in 1973 to turn the gas extracted from offshore oil fields in Abu Dhabi into a marketable source of energy instead of flaring it. The gas liquefaction plant that was built on Das Island underwent major development and expansion schemes that were capably executed by the Company's engineers. ADGAS currently produces about 8 mtpa of LNG, LPG, pentanes and liquid sulphur.

Development of GASCO's 3rd processing Train at Ruwais will increase its current output capacity by approximately 24,000 tpa. With a development investment of US$2.5 to 3.0 billion during the next three years, GASCO will become a world leader in the production of C2 and C5+.

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The Expanding World LNG Markets

By David Roe

This article looks briefly at LNG markets around the world on a country-by-country basis, and forecasts the future growth in LNG trade. Compared to 2003 levels, world LNG trade is forecast to double by the end of this decade, and to increase by a factor of nearly three by 2016. Although these forecasts are subject to uncertainty, there is no doubt that LNG trade is expanding faster than in the past, and at a rate significantly greater than the overall rate of growth of natural gas consumption worldwide.

Reasons for growth

The LNG industry has achieved a significant lowering of the costs in the LNG supply chain over the past five years, due to a combination of technological innovation, design optimisation, construction of larger facilities to achieve economies of scale and the incentive of increased competition.

The fastest growing industrial use of natural gas is in power generation. A new LNG reception terminal is well suited in size to meet the requirement of a new combined-cycle gas turbine (CCGT) power station (one of 1000 MW capacity needs about 1 million tonnes/annum – mta – of LNG). It is economically viable to establish an LNG reception terminal to supply a new power station and then expand the gas supply to other users as the local market develops.

In the USA the availability of indigenous gas supplies and pipeline imports cannot keep pace with the growing gas demand, particularly for power generation. Gas prices have risen and this is encouraging a surge in LNG imports.

LNG producers are playing an increased role in developing LNG markets and reception terminals to secure outlets for production from their export projects. Also, they are more willing to meet the buyers' expectations with regard to price and flexibility in LNG supply contracts.

LNG trade has become more liquid, with more short-term trade to destinations that vary according to changing market demand and prices. This also helps to support the development of projects pending the completion of long-term LNG supply contracts. Indeed, short-term and spot sales have grown from nearly zero before 1990 to 10.7% of LNG imports in 2003. However, the LNG business will continue to be based primarily on long-term supply contracts, which are needed to underpin the

The USA is seeing a surge in LNG imports. Lake Charles, Lousiana is one of the country's existing reception terminals, all of which are being expanded to help meet fast-growing LNG demand.

LEFT AND BELOW
One of the new projects that will supply growing LNG markets in the Asia-Pacific region is Russia's Sakhalin LNG plant, which will start exports in late 2007. These views show construction of Sakhalin Energy's onshore processing facility, which will process gas from the Lunskoye Field.

large investment in new projects. Some analysts predict that short-term and spot sales could account for 15-20% of LNG imports within a decade, and this growth of short-term trade is helping to speed up the development of projects. Developers are increasingly committing to construction of LNG supply projects before all the output has been sold under long-term contract, knowing that the existence of outlets for short-term trade means that there is a low risk that the plant will operate at under capacity before most or all the LNG has been sold under long-term contract.

In some regions, such as Europe, where countries have existing pipeline gas supplies, LNG imports provide diversity of supply. An LNG reception terminal in principle provides more flexibility and supply security, because of the existence of a choice of alternative or additional LNG supplies.

A new LNG supply scheme has certain advantages when competing with a new long-distance pipeline project, which can have a long gestation time, because it is not economic until the market has grown to a certain size. It is easier for an LNG scheme to start small and expand with the gas market. Moreover, security concerns and high transit fees can be constraints to long distance pipelines that pass through several countries.

Market liberalisation is attracting new players to the LNG business and opening up new commercial opportunities for LNG to supply growing gas markets.

● Asia and Australasia

Japan

Japan remains by far the largest importer of LNG in the world. The country's main LNG importing companies no longer have a complete monopoly over either city gas supply or power production in their particular region, which makes them uncertain about their future market share, and more cautious about committing to large volumes under long-term LNG supply contracts. LNG demand is likely to continue to grow at about 2% per year, but it could be higher if nuclear power cannot be expanded to the extent that is planned. Japan has 25 existing LNG terminals and two new LNG terminals are under construction. Much of the future growth in LNG imports will be catered for by

BBG's new LNG terminal at Bilbao – Spain is now Europe's largest LNG importer.

using excess capacity in existing terminals or by their expansion.

Korea

Korea is also embarking on liberalisation of its gas market, although the process has been delayed. Korea Gas Corporation (Kogas) is still the sole LNG importer, but that will change in 2005 when the new LNG terminal built by POSCO at Gwangyang comes into operation. Korea's LNG demand is growing faster than that of Japan, but has a large seasonal variation. Kogas is about to secure more long-term LNG supplies, is expanding the storage capacity at its three terminals, and has been securing shorter-term LNG supply contracts for delivery of LNG either wholly or mainly in the peak winter period.

Taiwan

Now that delays have been resolved in deciding on the supply of LNG for a 4000 MW new power plant, LNG demand is expected to grow more rapidly. CPC is to build its second LNG terminal, on Taiwan's west coast, and Tung Ting Gas is building a new LNG reception terminal at Taoyuan in the north-west.

India

In early 2004 Petronet LNG's Dahej was the first of India's LNG terminals to come into operation, having successfully found buyers in the end gas market. Petronet LNG has decided to expand Dahej and proceed with a second terminal at Kochin. Meanwhile, construction of the Hazira terminal (Shell/Total) is nearing completion. It is expected that market pricing issues will still constrain LNG imports, but by 2016 a total of four or five LNG terminals will be in operation.

China

China is proceeding with two LNG reception terminals: the first is under construction at Guangdong, and is due to open in 2006, and the second is soon to start construction at Fujian. CNOOC and other Chinese companies have plans for over 10 more LNG import terminals, and by 2016 it is expected that three or four will be operating. The potential LNG demand in China is very high, and LNG imports may grow at a faster rate, e.g. if there is less central government control over LNG project development.

Other Asian markets

An LNG terminal is planned for The Phillipines, to supply power generation projects, and at least one is planned for Indonesia. Singapore, Thailand and New Zealand have all recently studied the feasibility of LNG imports.

● Europe

Spain and Portugal

Spain has made the greatest strides towards full liberalisation of its LNG market, and has overtaken France as Europe's largest LNG importer. LNG demand is forecast to double within the next 10 years, due to the growth of gas-fired power generation, the competition resulting from a liberalised market and

constraints (either physical or for security of supply reasons) on new pipeline supplies. Enagas operates three reception terminals, all of which are being expanded. The Bahia de Bizkaia Gas (BBG) LNG reception terminal near Bilbao came into operation in 2003 and two others are under construction. LNG terminals are also planned for the Canary Islands. Meanwhile, Portugal has one LNG terminal at Sines, which came into operation in 2003.

France

The country is slowly moving towards gas market liberalisation. Gaz de France is still the sole LNG importer and operates two terminals. LNG demand will continue to grow again once LNG supplies arrive from the first Egyptian LNG export project, and after the completion in 2007 of the new Fos Cavaou reception terminal being established by Gaz de France and Total.

Belgium

Qatar Petroleum and ExxonMobil agreed in 2004 to take about half of the future capacity of the Fluxys Zeebrugge LNG terminal, which is to be expanded and doubled in capacity by 2007. Gas could be supplied into the European pipeline system and via the Interconnector pipeline to the UK.

Italy

Like Spain, Italy's potential LNG demand has been given a boost by market liberalisation and by the

Hoegh LNG's *Norman Lady* is on long-term charter to Gas Natural of Spain.

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The Expanding Role of LNG

By Philip J. Dingle, President of ExxonMobil Gas & Power Marketing Company

Global demand for natural gas will grow faster than for any other primary source of energy, increasing at an annual rate of nearly 2.2%. Natural gas is expected to account for one-quarter of the world's energy supplies by 2030, up from one-fifth today.

It is important to recognise that this growth is not limited to one region, but will occur across all parts of the world. This compounding annual growth over the next 25 years will have a staggering impact on demand figures. Natural gas consumption will nearly double from 275 billion cubic feet per day (bcfd) today to approximately 500 bcfd in 2030.

Since most indigenous supplies, near markets, have already been developed, this future growth in supply will come from remote locations. And, we anticipate that much of this supply growth will need to be transported across oceans, by ship, as LNG.

The United States is already the largest gas-consuming region in the world at about 70 bcfd or 25% of global consumption. We forecast that demand in the United States will grow at a modest rate compared to world growth. Today, most of the gas is supplied domestically, and from imports from western Canada

Higher prices, greater energy efficiency, conservation and domestic non-conventional sources will help our supplies go further. However, all of this together will not be sufficient to meet all the future requirements at reasonable prices. Imports of LNG will be a competitive alternative, as already the case in Europe and Asia.

In short, the United States will need all the gas we can get from all sources, if we are to sustain our economic competitiveness and prosperity, so we should be seeing more of LNG imported domestically.

In a study, the National Petroleum Council estimated that the United States would need to import roughly 10 bcfd of LNG by 2020. This is almost 10 times as much as today.

To enable LNG to better compete with indigenous sources of supply, ExxonMobil and the industry, are now building bigger LNG liquefaction plants, larger regasification terminals and larger tankers. By achieving economies of scale, we cut LNG supply cost by nearly 30% in the last five years.

In the late 1990s, the liquefaction of gas to LNG was done in processing plants with capacities up to about 300 million cubic feet per day (mcfd). Last year, ExxonMobil, started a new facility in Qatar, which is the largest liquefaction plant in the world, capable of 700 mcfd. And we are already starting the development of four other units, also in Qatar, that will exceed 1 bcfd each.

Ship size is also increasing with the latest designs growing from 135,000 cubic metres to 250,000. The result is we now have the ability to bring more LNG to the markets that need it, and we can bring it from further away.

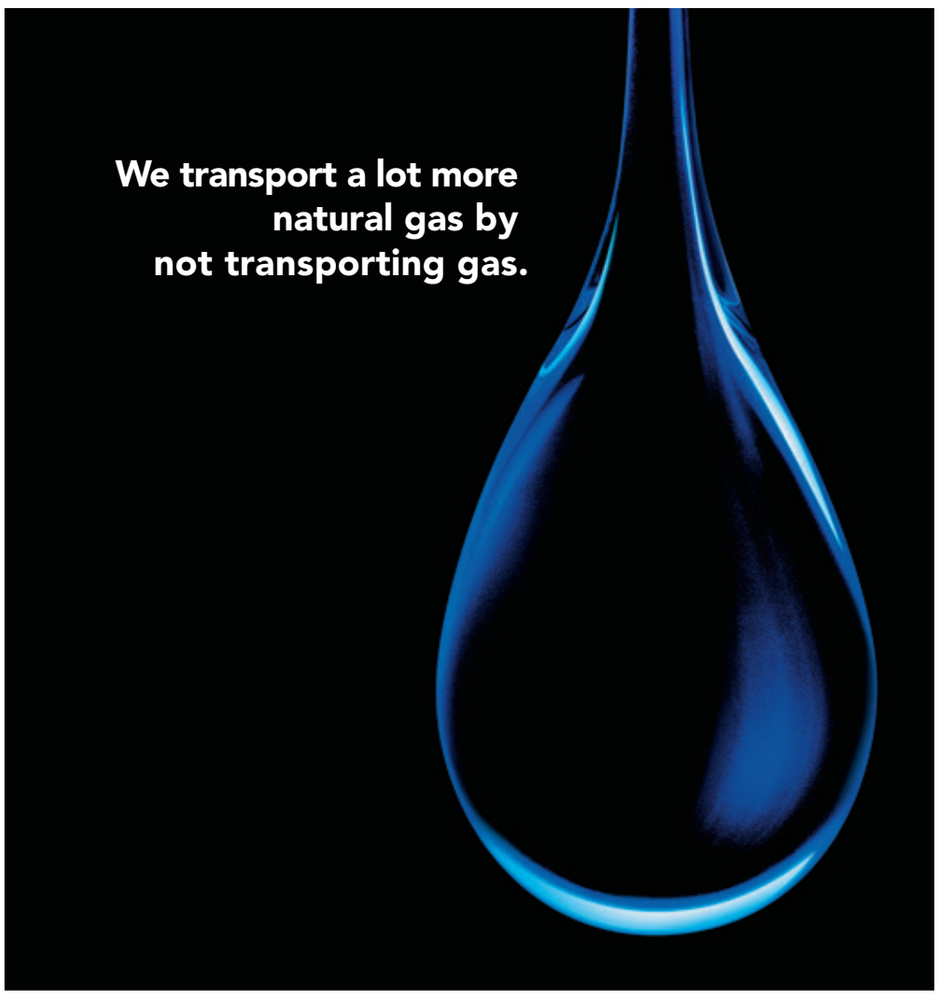
ExxonMobil has signed a Heads of Agreement with Qatar Petroleum to provide up to 2 billion cubic feet of LNG per day to the United States for a period of 25 years, beginning in 2008. Our partnership with Qatar is from wellhead to market, and one that will meet the need for a steady supply. The projects will both require construction of two of the world's largest liquefaction units.

In preparation for the arrival of the first LNG tankers in 2008, ExxonMobil and Qatar Petroleum are now in the permitting stage for two regasifcation terminals along the Texas Gulf Coast. We have also submitted a permit for a third facility in Louisiana.

It is these terminals that are a critical link between the new sources overseas and the existing market here in the United States. Even with our agreement with Qatar Petroleum, the United States is still expected to need an additional 8 bcfd by 2020. Without supply projects and more terminals, the industry will be unable to meet the projected need for LNG imports.

Domestic policy makers will be challenged to balance many issues, with the country's need for reliable, competitive energy. It is imperative that we find reasonable solutions.

In a world that needs more energy and lower emissions, natural gas has a vital part to play. It's abundant and clean-burning, can be produced and transported safely, and is increasingly important in generating electricity. Right now, most of the world's natural gas travels relatively short distances to reach the consumer.



But most large gas fields are far from the countries that need the gas. As world gas demand grows, the challenge is to deliver it economically, across increasingly vast distances. The answer is a piece of basic science. And a significant technological breakthrough. First, the science. If you cool any gas, it shrinks. If you cool natural gas to -260 degrees F, it turns into a liquid – and shrinks to one six-hundredth of its volume. So it can be shipped. It's called Liquefied Natural Gas. The industry has been developing it for years. But engineers at ExxonMobil have now transformed the scale on which LNG can be produced, shipped, and turned back into gas. Through partnerships such as our important joint venture with Qatar Petroleum, we can use this scale to bring new economies. This is good news for U.S. gas consumers. But the significance goes well beyond America. Natural gas is one of the world's cleanest fuels. It's also one of the fastest growing. In fact, experts predict that, by 2020, it will meet 25% of the world's total energy demand. And, as one of the world's largest suppliers of it, we're doing all we can to get it where it needs to be. *exxonmobil.com/energychallenges*

ExxonMobil

Taking on the world's toughest energy challenges.™

An artist's impression of the Sabine Pass LNG terminal to be built in Louisiana, USA.

need for new gas-fired power generation. At present Italy has only one LNG terminal, at Panigaglia, operated by Snam. LNG imports are set to increase after the development of two planned new LNG terminals in the Adriatic: offshore Rovigno (ExxonMobil) and Brindisi (BG). Several other terminals are being studied or planned.

Turkey and Greece

LNG demand in Turkey and Greece is constrained by competition from pipeline gas supplies. There is one terminal in Turkey, operated by Botas at Marmara Ereglisi, and another (the Izmir terminal of Egegaz), whose start-up has been delayed. As gas demand grows, it is forecast that Turkey will increase its LNG imports again in the longer term. DEPA of Greece currently imports only a small quantity of LNG through its Revitthousa terminal, which may be expanded in future. LNG imports to Cyprus are planned, and studies have been undertaken of the feasibility of LNG supplies to the larger Greek islands such as Crete.

United Kingdom

Because of declining UK gas reserves, the need for gas imports to the UK is growing fast. Transco's Grain LNG terminal in the south-east is nearing completion and there are plans for its expansion. Two new LNG terminals at Milford Haven in Wales are starting construction: South Hook (ExxonMobil/Qatar Petroleum) and Dragon (BG/Petronas/Petroplus).

The Americas

South America and the Caribbean

In the Caribbean, LNG is currently shipped from Trinidad to Puerto Rico and the Dominican Republic to supply gas-fired power generation. Although small, this is a growing market. Jamaica will import LNG from 2010.

LNG terminals in north-east Brazil have been under study for some time. In 2004 feasibility studies were undertaken for an LNG import terminal in Chile. It is probable that at least one South American LNG reception terminal will come into operation in the next 10 years.

North America

The USA has four LNG reception terminals – one on the Gulf coast (Lake Charles) and three on the east coast (Everett, Cove Point and Elba Island). All are being expanded.

Many analysts foresee a future in the USA with prices staying above $3.5 /million Btu for much of the time – sufficient to sustain a considerable rise in LNG imports. There is no "volume" constraint on the US LNG market: the size will be determined mainly by price and the economics of LNG in relation to pipeline gas. Over 30 new LNG terminals have been seriously studied, or are planned. One, using Excelerate's Energy Bridge shipboard regasification concept, comes into operation in

2005 offshore Louisiana. At least four terminals are on the point of starting construction: Freeport in Texas (Freeport LNG, ConocoPhillips, Cheniere and others); Cameron in Louisiana (Sempra Energy); Sabine Pass LNG in Louisiana (Cheniere with ChevronTexaco and Total also having capacity rights); and Port Pelican offshore Louisiana (ChevronTexaco). A terminal is planned for the Bahamas, to supply gas markets in Florida by pipeline. There are also LNG terminals being planned for the east coast of Canada, to supply local and north-eastern US markets. Mexico has one LNG terminal under construction on the Gulf coast, at Altamira (Shell/Mitsui/Total). On the Atlantic/ Gulf coast it is forecast that four or five new terminals should come into operation in the next five years, and a further three or so before 2016.

Several terminals are planned for the Pacific coasts of the US and Mexico. The most advanced is Mexico's Costa Azul terminal (Shell/Sempra), which is just starting construction and will supply local and Californian gas markets. On the Pacific coast the growth in LNG imports may be more constrained than on the Atlantic coast because of the greater availability of new pipeline gas supplies, and the higher costs associated with the long shipping distances from LNG supply sources in Asia/Australia. About three of the planned LNG reception terminal projects may come to fruition by 2016.

Smaller scale LNG markets

Much attention has been paid to recent increases in the size of liquefaction trains, and LNG carriers, to achieve economies of scale. However, while the largest plants, terminals and ships get bigger, there is also a growth in smaller-scale LNG projects. As the unit costs of LNG supplies continue to fall in relation to the market price of natural gas, smaller-scale LNG reception terminals (e.g 1 mta or less) become more economic, supplying new power stations under 1000 MW. These new power generation projects are more efficient if the power station can be physically or process integrated with the reception terminal.

There is also a growing market for LNG transported by road tanker, by rail (in containers), or by small LNG ships, supplied to LNG satellite storage facilities for distribution by pipeline to local

Road tanker loading facilities at the Nagasaki LNG terminal in Japan for supply of LNG to satellite storage installations.

Trinidad and Tobago – World-Scale Natural Gas Economy

Trinidad and Tobago is expected to register its 11th straight year of economic growth in 2004, following on growth of 4.1% in 2003. Performance in the energy sector has been particularly robust, aided by high oil and petrochemical prices.

The industry grew consistently through the 20th century when domestic oil production peaked at 229,500 barrels per day (bpd) in 1978. Since that time oil production has been in decline to its current level of about 125,000 bpd. It is anticipated however that with BHP Billiton's new offshore field coming onstream with initial production in the region of 70,000 bpd, there will be a significant uplift in oil production for the first time in several years.

Natural gas sector

The first phase

By 1992 the domestic petrochemical sector had progressed to the point where it included:

- One methanol plant;
- Five ammonia plants;
- One urea plant;
- One iron and steel mini mill;
- A cryogenic gas processing facility; and
- Expanded power generation capability.

Phase two – 1992-2001

Using the existing plants and infrastructure as a base, and buoyed by the excellent cost and operating history at the Point Lisas Industrial Estate, installed producing capacity increased at an impressive rate. As a consequence the country's gas utilisation increased from 400 million standard cubic feet per day (mscf/d) in 1992 to 1044 mscf/d by 2001 excluding LNG production.

The gas-based petrochemical sector now included:

- Eight ammonia plants 3.7 million tonnes per year (mtpa);
- Five methanol plants 2.9 mtpa;
- Three iron and steel mills 2.36 mtpa;
- One urea plant 500,000 mtpa;
- Liquids' recovery plant 1.4 billion cubic feet/day capacity + NGLs output of 33,500 bpd; and
- Four power generating plants 1400 MW.

LNG

Atlantic LNG Train 1 was a benchmark project, which started in 1999. Its initial success was closely followed by a two-train expansion, Trains II and III, which commenced production in 2002 and 2003 respectively and increased LNG production capacity by 6.6 million tonnes, to a total of almost 10 million tonnes per year.

This country is now by far the largest exporter of LNG to the United States, accounting for 74% of that country's LNG imports in 2003. A fourth train, (5.2 mtpa and 800 mscf/d) is under construction and is scheduled to begin operation by the fourth quarter of 2005.

Reserves

At the present time natural gas production and consumption averages about 2.8 bcf/d, with 52% going to LNG production and the balance (48%) utilised in domestic conversion.

Consumption is scheduled to increase to over 4.0 bcf/d before the end of the decade and if this level of utilisation is to be sustained over the long term, it will require a robust and growing resource base – both to meet existing and future demand, as well as to give the kind of comfort required by major investors to participate in what is deemed an "off-shore, stranded" gas location.

In 2003, after 10 years of robust consumption, certified 3P reserves stood at 34.8 tcf. In addition, consultants Ryder Scott Company estimate that the country's potential gas reserves are in the region of 60 tcf.

Current developments

Transmission capacity

The pipeline network of the Natural Gas Company of Trinidad and Tobago (NGC) consists of approximately 624 kilometres of offshore and onshore transmission and distribution lines with a delivery capacity of 1.4 bcf/d. As merchant and transporter of domestic natural gas, NGC has continuously had to match pipeline capacity with growing demand, and the network is seemingly in a continuous state of expansion.

The Company is currently close to system capacity and is well advanced in the construction of a 36-inch-diameter offshore pipeline and a liquids receiving facility that will link up to the on-shore network and increase domestic system capacity to 2.0 bcf/d. This is due for completion by the second quarter of 2005.

NGC is also constructing a 56-inch-diameter, 76.5-kilometre on-shore pipeline to the Atlantic LNG plant at Point Fortin. This line will have a capacity of 2.4 bcf/d and supply Atlantic Train 4, along with existing and future LNG trains and new industrial estates currently being developed. Completion is scheduled for August 2005.

Industrial estates

The Point Lisas Industrial Estate is now effectively at full capacity, and sites for new industrial expansion are under development at La Brea and Union Estate, south Trinidad. Already much of Union Estate (800 acres) has been committed, and further sites are actively being evaluated.

Plants under construction

- **Atlantic LNG Train 4**
  A 5.2 mtpa LNG processing plant – completion by Quarter 4, 2005
- **Methanol 5000**
  With a capacity of 5000 tonnes per day (1.7 mtpa) – start-up in Quarter 2, 2005
- **DRI Plant**
  A 1.6 mtpa DRI metals – completion by Quarter 4, 2005

Size doesn't matter

When your potential is this BIG!

We may be but a dot on the world map, but this small country has a lot to offer. Not only are we home to some of the biggest multinational oil and natural gas companies in the world, we're also the world's fifth largest liquefied natural gas producer and exporter, and the world's largest exporter of ammonia and methanol.

And that's not all. Every year, more and more billion-dollar companies are choosing Trinidad and Tobago to be their new base. Our attractions include significant natural resources, a stable economy, strategic location, and a skilled labour force.

The National Gas Company of Trinidad and Tobago Limited (NGC), and its subsidiary company, National Energy Corporation of Trinidad and Tobago Limited (NEC), are creating the infrastructure for Trinidad and Tobago to remain a prime investment location in the Western Hemisphere.

So if you're looking for the ideal location for your business, then look no further. Now is the time. Trinidad and Tobago is the place.

TRINIDAD AND TOBAGO… small islands – BIG OPPORTUNITIES

THE NATIONAL GAS COMPANY OF TRINIDAD AND TOBAGO LIMITED
www.ngc.co.tt

Frank Look Kin
President
The National Gas Company of Trinidad and Tobago Limited (NGC)
Orinoco Drive
Point Lisas Industrial Estate
Couva
Republic of Trinidad and Tobago
West Indies

Tel: (868) 636-4662/4680 **Fax:** (868) 679-2384 **Email:** flk@ngc.co.tt

NATIONAL ENERGY CORPORATION OF TRINIDAD AND TOBAGO LIMITED

Prakash Saith
President
National Energy Corporation of Trinidad and Tobago Limited (NEC)
Corner Factory and Rivulet Roads
Brechin Castle
Couva
Republic of Trinidad and Tobago
West Indies

Tel: (868) 679-1156/1061/1138/2453 **Fax:** (868) 636-2905 **Email:** Prakash@ngc.co.tt

markets, or to industrial customers with their own LNG storage. The LNG can come from LNG reception terminals, LNG peak-shaving plants or smaller-scale purpose-built liquefaction facilities, including those associated with larger scale cryogenic gas processing plants and with gas pipeline pressure reduction stations. Such markets include the use of LNG as fuel in vehicle fleets – trucks and buses, or as a means of more economically producing compressed natural gas (CNG) at CNG vehicle refuelling stations. LNG is also used in Norway as fuel on ferries and offshore rig supply vessels.

Recent projects include:

- A "mid-scale" plant that has just been built at Shan Shan, Xinjiang-Province in north-west China. Associated gas from a nearby oil field is liquefied, the LNG is loaded into containerised vessels and transported by train over several thousand kilometres to satellite storage facilities in the east of China. It is the largest such purpose-built plant in the world, of capacity 0.43 mta (about one tenth the size of a typical train at a modern baseload LNG export plant).
- A project in western Japan for transhipment of LNG from the Kitakyushu reception terminal by 2500 m^3 capacity LNG carrier to marine satellite facilities for supply to gas utilities. In future the trade will be expanded to 0.17 mta or more.
- A small plant at Kollnes, Norway, which supplies LNG by 1000 m^3 capacity LNG carrier to several marine satellite facilities around the coast of Norway for industrial use; LNG is also supplied to customers by road tanker.

The total quantity of LNG used in such applications is presently small in relation to world LNG trade, but the future potential number of possible new projects is very high and they are important in developing new market opportunities for larger LNG trade. These are cases where there is a conveniently situated baseload LNG reception or even export terminal, or where there are sources of "stranded" gas insufficiently large to support large-scale LNG export projects, and where there are local factors which make LNG transport more attractive than pipeline transport.

Forecast future LNG imports

Tables 1 and 2 show actual LNG imports in 2003 compared with estimated future LNG imports for the years 2010 and 2016, on a country-by-country basis. The estimates take into account:

- Statistics so far available for LNG trade in 2004, plus firm contracts and provisional agreements for future LNG supplies;
- Published forecasts and analysis of gas markets from reputable sources;
- The scale of activity in studying or planning LNG reception in specific markets, and potential supply projects targeting those markets; and
- The likely start up dates of future LNG supply projects based on realistic schedules, rather than project developers' more optimistic targets, to make sure that the LNG market forecasts were consistent with an achievable LNG supply over-capacity of 5-10%.

Conclusions

The average rate of growth of LNG trade until 2010 is about 10% per year, higher than in the past (nearly 7% per year on average over the last 10 years), and more than three times the expected overall rate of increase in gas demand. This reflects the fact that more opportunities are opening up for LNG, owing to continued reductions in LNG supply costs, the increased flexibility and competition in LNG trade, and the fact that for many markets LNG is improving its competitive position in relation

to pipeline gas supplies and alternative energy sources.

By 2010 the total growth in LNG demand in new Asia-Pacific markets (China, India, the west coasts of the US and Mexico) will exceed the total growth in demand in the traditional markets (Japan, Korea and Taiwan). By 2010 the USA will be the world's second largest LNG importing nation, and by 2016 LNG trade in the Atlantic Basin will have grown to such an extent that it will be of a similar size to that in Asia-Pacific.

The greatest uncertainty in these forecasts is the future extent of LNG imports to the USA. Some in the US LNG industry are more optimistic, predicting up to 50% more LNG coming into the USA in the next 10 years than is predicted here. However, the full potential is unlikely to be achieved owing to delays in establishing new LNG terminals and in securing the supply and shipping infrastucture, and because of the inhibiting effect of price volatility on project developers and their financiers. It is possible, but unlikely, that there could be significantly less than predicted here, e.g. if market prices fall to below $2.50/million Btu for a prolonged period, or if for whatever reason the US government changes its policy and no longer encourages LNG imports. However, LNG trade is now sufficiently global in nature that if the US LNG trade is smaller than forecast, some new LNG supplies intended for the US will find their way instead to LNG markets in Europe and Asia. Likewise, if US LNG trade is larger than forecast, some new LNG supplies intended for Europe or Asia will be diverted to the USA. There will thus be a smaller effect on total world LNG trade.

David Roe is an independent LNG consultant and Editor of the LNG Journal *(www.lngjournal.com). Until 1995 he worked for British Gas on LNG studies and for several years in the 1980s he was the UK representative on the then IGU working Committee H-1 (LNG).*

RIGHT
Table 1.

ASIA-PACIFIC – LNG IMPORTS

Country	*million tonnes/year*		
		Forecast	
	*2003**	*2010*	*2016*
Japan	58.5	66	72
Korea	19.4	26	32
Taiwan	5.6	12	17
India	-	10	15
China	-	7	13
US & Mexico (West Coast)	-	6	12
Others	-	3	5
Total	**83.5**	**130**	**166**

* **Source:** for 2003 figures GIIGNL

RIGHT
Table 2.

ATLANTIC BASIN – LNG IMPORTS

Country	*million tonnes/year*		
		Forecast	
	*2003**	*2010*	*2016*
Spain & Portugal	12.3	25	30
France	9.2	12	17
Belgium	2.5	6	7
Italy	2.5	9	15
Turkey & Greece	3.9	5	8
UK	-	8	11
US, Canada, Bahamas	10.5	38	62
Mexico	-	3	5
Caribbean	0.8	4	7
Others	-	3	5
Total	**41.7**	**113**	**167**
World Total	**125.2**	**243**	**333**

* **Source:** for 2003 figures GIIGNL

The 40th Anniversary of LNG Exports

By William T. Blacklock

Last year was the 40th anniversary of the start of commercial LNG exports with a delivery from Algeria to the UK. The Algerian Gas Association and the country's national oil and gas company, Sonatrach, commemorated the occasion with a celebration in September marking the inauguration of the liquefaction plant in Arzew. This was followed in October by an event organised by the Society of International Gas Tanker and Terminal Owners (SIGTTO) to mark the arrival of the shipment on-board the *Methane Princess* at Canvey Island.

The *Methane Princess* and its sister ship *Methane Progress* were the first purpose-built LNG tankers. Each had a capacity of 27,400 cubic metres with the *Princess* built by Vickers Armstrongs at Barrow-in-Furness, UK, and the *Progress* built by Harland & Wolff in Belfast, UK. Although sister ships they were not identical twins; both were designed to divert LNG boil-off to fuel the boilers, while the *Progress* additionally had an on-board re-liquefaction plant. (The boil-off was metered and charged to Shell as the ship's operator.) The *Princess's* system was tested at sea for the first time during the delivery voyage and worked perfectly; today such systems are common on LNG tankers.

Given the technological challenges of setting up the first LNG export chain, it was a credit to all the parties involved that the only significant problem was related to establishing the specific gravity of the cargo. On a technical level this was a minor issue, but of course on a financial level it was crucial as the specific gravity of an LNG cargo determines the tonnage and therefore the amount billed by the supplier. The problem was that while the specific gravity of the LNG was known at the point of issue from the plant, there were doubts about the exact value after it had passed through the pipes into the ship. As we argued to three decimal places the delays mounted and in the end we had to sail from Arzew with the ship only 60% full.

The UK Gas Council had organised a welcoming ceremony at the Canvey Island receiving terminal so we had a delivery schedule to meet. On October 12, 1964 the *Methane Princess* delivered the first commercial cargo of LNG. That "minor" billing problem was soon resolved and in the course of 40 years the global LNG trade has expanded to reach 124 million tonnes (170 billion cubic metres) in 2004.

The *Methane Princess* at Canvey Island in Essex, UK.

William T. Blacklock was the Lloyd's Register surveyor on board the Methane Princess *making the first commercial delivery of LNG in October 1964.*

Independent Assurance

Recent developments in other industry sectors have demonstrated the advantages of separating "technical assurance" from "consultancy".

Independent third party assurance gives stakeholders, including operators, confidence that a facility can be operated safely. Certified assurance of compliance with rules and guidelines is frequently mandated to confirm the technical adequacy of potentially hazardous infrastructure. In other situations, independent assurance provides related parties with confidence in the technical solution, and can be used as a basis for triggering stage payments during construction, or reduced insurance premiums during operation of facilities.

In all circumstances where independent certification is required, the integrity of the independent body is paramount. A certificate has little value if there is any doubt about the competence or integrity of the organisation issuing it.

Since its inception, the gas industry has continued to develop new methods of transport and storage, and Lloyd's Register has been there every step of the way, ensuring, in accordance with our constitution, "high technical standards of design, manufacture, construction, maintenance, operation and performance for the purpose of enhancing the safety of life and property…". In 1964 the first commercial LNG cargo was delivered by the *Methane Princess*, a vessel designed and constructed with the assistance of Lloyd's Register. Our services now include advising regulators on the requirements to be applied to the design of gas terminal facilities.

The Lloyd's Register Group combines its extensive experience in the marine and oil and gas sectors to help our clients deliver their products to their consumers safely and cost effectively. We can provide independent assurance for the complete gas delivery chain, from production through to final consumption.

As we look to the future, the next generation of LNG ships together with the development of offshore and onshore LNG technology will present a new set of challenges. The Lloyd's Register Group has proved time and again that it is ready and able to help the industry find and be confident of the innovative solutions that will enable technical advancement in a safe and effective manner.

You may already know that natural gas is one of the most environmentally friendly fuels in the world. It produces almost no emissions of sulfur dioxide or particulates and leaves no solid waste behind, which means less impact on air and water quality. You may also know that natural gas demand is soaring; worldwide consumption is projected to nearly double by 2030. What you may not know is that ChevronTexaco is working with governments and partner companies to secure the largest deposits of natural gas in Australia for shipment to North America and Asia. A steady supply of cleaner fuel to light our homes and keep us warm? Sounds like a lot of g'days to come.

www.chevrontexaco.com/naturalgas

ChevronTexaco
Turning partnership into energy.™

The Promise of the Natural Gas Era

The surge in worldwide energy demand, which could increase by almost 60% by 2030 according to the International Energy Agency (IEA), brings with it significant opportunities for the natural gas industry. Growing at a much faster pace than oil, global consumption of natural gas is predicted to nearly double over the next 25 years, driven primarily by power generation.

Fortunately, the planet's proven reserves of gas have also grown steadily. The IEA, US government and others estimate that reserves stand at approximately 6,000 trillion cubic feet (tcf), almost twice as high as 20 years ago. Based on current consumption levels, that is enough to meet world demand well into the second half of the 21st century. Earth scientists believe there are still many gas resources to be found and produced.

The Natural Gas Era is here, holding great promise for those who are up to the challenges of world-class competition. Huge growth potential exists on several fronts: liquefied natural gas (LNG), gas-to-liquids (GTL), and hydrogen from gas as a major, new transportation fuel. However, optimising all three will test the industry in many ways and require new partnerships among companies, governments, customers and the public.

With extensive gas resources across six continents, ChevronTexaco is developing multiple projects on all three fronts, forging strong partnerships and engaging in the pragmatic actions needed to fully realise the potential of the Natural Gas Era.

LNG: global expansion and North America's disconnect

LNG shipments from resource-rich areas to markets where demand is outpacing indigenous supply will drive much of the increased gas consumption in the coming decades. The IEA predicts a four-fold increase in inter-regional LNG trade by 2030.

In Asia, natural gas demand in Japan and Korea, already reliant upon LNG imports, will continue to increase steadily. Gas consumption in China and India is expected to grow strongly, with LNG helping to meet the demand. In Europe, LNG imports could double within the next 15 years. However, the real LNG "game-changer" is North America. Gas and power demand are growing, while at the same time the industry is striving to maintain present North American natural gas output. Although historically a small LNG buyer, US imports of LNG are expected to grow from 0.4 tcf in 2003 to 4.8 tcf in 2025, according to the US Department of Energy's Energy Information Administration.

Without new, reliable supplies of LNG, North America can expect future gas prices to be higher and more volatile, reducing economic competitiveness. Utilities will opt for less desirable fuels to meet rising power demand. High prices and uncertainty are already forcing industry and jobs to move elsewhere to find cheaper, more secure energy. Further, without a major, new North American LNG market, planned LNG export projects, such as those ChevronTexaco is developing in Africa, Australia and Latin America, could be downsized or delayed indefinitely, dissolving hopes for new energy-trade revenues, particularly in the developing world.

Natural gas needs to be commercialised sensibly but aggressively for North America. New LNG import facilities are needed on the East, West and Gulf Coasts to meet projected demand. However, some local officials and citizens have already said "no" to new LNG terminals from Maine to California, citing environmental and safety concerns. The LNG industry has an exceptional decades-long safety record. More then 33,000 LNG voyages, covering more than 60 million miles, have been completed without major accidents or safety issues in port or at sea. From an environmental standpoint, the public wants clean energy, and natural gas-fired power plants offer the best combination of reliability, cost efficiency and environmental friendliness for generating electricity. Yet, LNG faces daunting opposition.

Addressing this disconnect will require honest and fact-based dialogue. Discussions about energy need to be rooted in the pragmatic middle ground – addressing legitimate public concerns, but driven by economic realities. For new LNG import terminals to become a reality, the industry must do a better job of educating the public about the need for, and the merits of, LNG. Government agencies, the business community and energy companies must work together to shift the discussion around LNG away from the "not-in-my-backyard" arena to a dialogue about practical solutions. Environmentalists should continue to hold industry accountable for protecting the environment, but also recognise the economy's need for more natural gas and accept LNG supplies as environmental progress, if not perfection.

ChevronTexaco is engaged in such discussions as it pursues a number of options for bringing LNG to the US and Mexico. The company has received US government approval to build and has completed initial engineering work for its Port Pelican terminal located offshore in the Gulf of Mexico. The company also has a 20-year terminal use agreement for regasification capacity at Cheniere Energy's Sabine Pass LNG terminal being developed onshore in Cameron Parish, Louisiana. And, ChevronTexaco is exploring the possibility of constructing an LNG terminal adjacent to its Pascagoula Refinery complex in Mississippi. On the West Coast, the

company is obtaining key permits and conducting front-end engineering design for a terminal to be built offshore Baja California, Mexico. ChevronTexaco continues to evaluate other opportunities along the coasts of the United States.

GTL: the champagne of diesels

Picture the perfect transportation fuel: easy to ship and store, able to blend with diesel, has high cetane, and contains virtually no sulfur or aromatics. That's GTL Diesel, the "champagne of diesels", and it's poised to help meet growing diesel demand around the world. The IEA predicts that GTL plants will emerge as a major new market for natural gas and that global demand for gas from GTL producers will surge from 4 billion cubic metres (bcm) in 2002 to 214 bcm in 2030.

Vast resources of gas stranded in northern Qatar could be shipped as GTL diesel to markets in Europe, Japan and the United States. Some gas-rich countries see GTL potentially enhancing energy security by reducing dependence on imported oil.

Based on known projects and the strong intent of major GTL developers, such as ChevronTexaco, a 700,000 barrel-per-day GTL industry by 2015 is a reasonable prediction – and perhaps 1.2 million bpd by 2020. However, technology must continue to evolve to make GTL more cost-competitive and attractive to investors and customers, while new markets for GTL must be cultivated. The first commercial-scale GTL plants – planned for Qatar, Nigeria and other countries, will set the stage for growth.

ChevronTexaco, through its joint venture Sasol Chevron, is pursuing GTL projects in Nigeria, Qatar and Australia. By 2008, the company and its partners expect to market 70,000 bpd of clean, high performance fuels from an exclusive GTL process, and plan to be well advanced on the development of an additional 200,000 barrels of GTL production.

In terms of GTL markets, Europe has set a remarkable pace by promoting advanced diesel cars and trucks. As European fuel specifications get tougher, the market for GTL diesel as a blendstock will grow, giving the first commercial GTL plants a customer base. As other regions see the success of advanced diesel, demand will mushroom and so will the GTL industry's capacity. However, the GTL industry must prove its competitiveness with the first plants, apply what it learns and improve technology to drive costs down. The sooner that is accomplished, the sooner the GTL solution can be applied in more places.

Hydrogen: taking it to the next level

Beyond LNG and GTL, hydrogen could be a unique element of the world's energy future. Most of the 40 billion cubic feet (bcf) of hydrogen the world currently produces per day is made from natural gas and used in oil refining. Although hydrogen's viability as a widely used fuel is years away, investment now will help assess its practicality and potentially accelerate its commercial viability.

Today, stationary fuel cells – most of which consume gas to make hydrogen for power generation – provide supplemental, clean, reliable power to data centres, hospitals and other facilities needing high-quality power, including ChevronTexaco's headquarters in San Ramon, California. But transportation offers a far bigger, long-term opportunity. Fleets, buses and trucks will lead the way, and as hydrogen infrastructure expands, cars will likely follow. It will take approximately 2.5 bcf of natural gas to make enough hydrogen to run 50,000 typical fuel-cell passenger cars for a year. For five million fuel-cell vehicles, 250 bcf of gas per year is needed. With more than 250 million cars in the US alone, the potential for hydrogen – and therefore natural gas – is obvious.

The vision of a hydrogen economy is promising. With world-class technology now transforming hydrogen from a specialty chemical to a clean fuel, more can be learned about hydrogen's potential. Partnerships will be important to develop safe, efficient and cost-effective ways to generate, transport, store and dispense hydrogen.

ChevronTexaco is working with partners to develop prototype hydrogen energy stations that will demonstrate the viability of hydrogen fuels. Currently under construction in Oakland, California, a prototype station will fuel a fleet of hydrogen-powered fuel cell buses operated by the Alameda-Contra Costa Transit District. The station will also have the capability to add a stationary fuel cell and use excess hydrogen to generate electricity. Additionally, ChevronTexaco, Hyundai Motor Co. and UTC Fuel Cells were selected to lead a five-year project sponsored by the US Department of Energy to demonstrate and validate practical applications of hydrogen energy technology.

Natural gas: fuel of choice

The opportunities in the Natural Gas Era are plentiful and the task is clear: the industry, in partnership with governments, customers and others, must focus relentlessly on making this abundant and clean fuel perform in every way possible. We must do so with an unwavering commitment to ongoing public dialogue, safety and reliability. The results will be succeeding in North America with LNG, building a profitable GTL industry, and moving hydrogen closer to reality, year by year.

GTL Goes Mainstream

By Mark Blacklock

Eight decades after Franz Fischer and Hans Tropsch developed a coal liquefaction process that produced high-quality diesel and over half a century after the process was first used with natural gas as a feedstock, the gas-to-liquids (GTL) business is at last set to become a real player in the global energy market.

The original development of synthetic fuels was subsidised for strategic reasons; the challenge of more recent R&D has been to develop commercially-viable processes. Eight principal proprietary technologies using the Fischer-Tropsch (F-T) process have been developed and refined in pilot projects and two commercial plants.[1] These successful efforts to reduce costs, together with tougher environmental standards that favour GTL fuels and rising energy prices have now given GTL the green light: a coal-to-liquids (CTL) plant has been converted to use gas as a feedstock, three new GTL plants are set to come onstream and more developments are planned. While their output will only represent a small proportion of the overall market for refined hydrocarbon products, in certain sectors – particularly diesel – it represents a significant development.

The pioneering commercial plants are in South Africa and Malaysia, while the confirmed new plants are in Qatar and Nigeria, and feasibility studies have been completed or are underway in Brazil, Bolivia, Egypt, Indonesia, Iran, Papua New Guinea and Russia. Typically automotive diesel with virtually no sulphur or aromatics and a high cetane number accounts for around two-thirds of the products slate, the remainder being mainly naphtha suitable for petrochemical feedstock.

In terms of natural gas feedstock there is a large and a small scale to GTL. On one hand there are very large gas fields – such as Qatar's North Field – where GTL is a supplementary means of monetising reserves. At the other extreme are gas resources that are currently untapped or flared because they are too small or remote to justify investment in transport facilities. Ras Laffan in Qatar aims to become the "GTL capital of the world" and developments there are covered by Gina Coleman on pages 126-128. Here we look at the key projects in the rest of the world.

1 For a more detailed discussion of the technologies and pilot projects see *Seven Decades with IGU*, pp166-178.

Production at the 1,000 b/d Petro SA/Statoil GTL plant in Mossel Bay is underway and the demonstration phase is due to be completed by the end of 2005.

South Africa and Malaysia

The first commercial GTL plant was built at Mossel Bay in South Africa by Mossgas (now part of Petro SA) using Sasol's synthol technology. It started operations in 1991 with a production capacity of 22,500 b/d for the domestic market.

Sasol had developed synthol for use with coal as a feedstock and had commissioned plants at Sasolburg in 1955 and Secunda in 1980. It went on to develop the slurry phase distillate (SPD) technology and opened a small (2500 b/d) plant using SPD in Sasolburg in 1993. Sasol later teamed up with Haldor Topsøe and Chevron (now ChevronTexaco) to refine SPD for the international market and set up a joint venture company with

The Bintulu GTL plant in Sarawak, Malaysia.

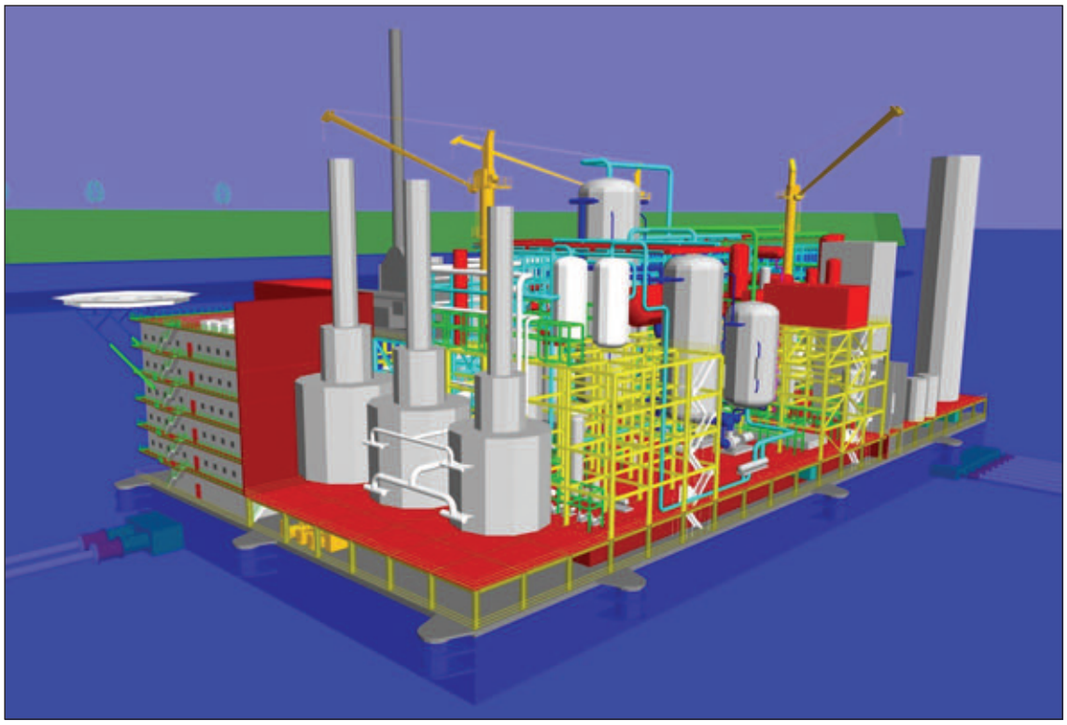
Chevron in 2000. At home in South Africa Sasol started work on converting its operations from coal to natural gas feedstock and a gas pipeline was opened in June 2004 bringing supplies from Mozambique to Secunda, where the new pipeline connects with the existing network. Natural gas now accounts for 100% of the feedstock for the Sasolburg operations and approximately 3% for Secunda.

Meanwhile, Petro SA has built a second, semi-commercial plant at Mossel Bay as a joint venture with Statoil using the latter's gas-to-middle distillates technology. This started operations in April 2004 and has a capacity of 1000 b/d. The demonstration phase is due to be completed by the end of 2005, when the technology will be ready for application in full-scale commercial plants.

The Malaysian plant was built at Bintulu by a consortium of Shell Gas BV (whose shareholding is now 72%), Mitsubishi's Diamond Gas Holdings (14%), Petronas (7%) and the Sarawak government (7%) to use the Shell middle distillate synthesis (SMDS) technology. With a capacity of 12,500 b/d it operated successfully from 1993 until December 1997 when an explosion in its air separation unit (ASU) caused a shutdown. The explosion was found to have been caused by the build-up of air-borne contaminants from forest fires. The plant was repaired and upgraded, and restarted operations in May 2000 with a capacity of 14,700 b/d, all of which is exported.

Stranded gas resources

GTL is a means of monetising gas resources that are too small or remote to justify investment in pipelines or LNG facilities. By converting natural gas to products that are liquid at ambient temperatures the costs of transport are reduced. Having



Syntroluem's GTL barge has a capacity of 19,300 b/d.

developed a proprietary technology of which Ivanhoe Energy, Marathon and Repsol-YPF are major licensees, this is an area that Syntroleum has been focusing on with its GTL barge. As Syntroleum uses air rather than pure oxygen in the first stage of processing (converting the feedstock into syngas) there is no need for a separate oxygen plant. Thus an entire GTL facility can be accommodated on an "inland" barge i.e. one designed for use close to shore.

Syntroleum is looking at gas fields in the 1-3 tcf (28-84 bcm) range and the barge would produce 19,400 b/d with a smaller emphasis on diesel than a typical land plant (8000 b/d of diesel, 7000 b/d of naphtha and 4300 b/d of LPG) based on a daily feedstock of 170 mcf (4.76 mcm).

Each barge is expected to have a price tag of around $300 million and Syntroleum has signed a Memorandum of Understanding (MoU) with Dragados (a subsidiary of Spain's ACS construction group, which builds offshore platforms, modular plants, large-scale equipment and metal structures) to evaluate financing methods. The two are looking at a "tolling" option whereby Dragados finances the barge and recoups its costs through a toll per barrel produced.

Nigeria

The key prospect for the GTL barge is a Nigerian offshore sector covered by Yinka Folawiyo Petroleum's Oil Mining Lease 113. This includes the Aje Field, which contains potentially commercial volumes of crude oil, condensate and natural gas liquids, but has needed a viable development solution since its discovery in 1996 due to the large natural gas volumes present. Syntroleum has teamed up with the Nigerian company and Sovereign Oil & Gas to work on development plans. "We hope to have a delineation well drilled sometime in early-to-mid 2005," says Syntroleum

President and Chief Operating Officer Jack Holmes.

Nigeria is already developing the Escravos GTL plant (EGTL) using Sasol's SPD technology, which will have a capacity of 34,000 b/d (22,000 b/d of diesel, 9500 b/d of naphtha and 2000 b/d of LPG). EGTL owners are Chevron Nigeria (75%) and Nigeria National Petroleum Company (25%), while Sasol Chevron is working on the plant's design and development and will provide management, operating and technical services to the project owners. Sasol Chevron will also market products from EGTL. Front-end engineering and design (FEED) has been completed, site preparation is underway and engineering, procurement and construction (EPC) bids are being evaluated. The plant is one of the ways of meeting the Nigerian government's 2008 target for eliminating the flaring of associated gas.

● Papua New Guinea

Syntroleum is also evaluating the use of a GTL barge in the Gulf of Papua in Papua New Guinea in a feasibility study with Oil Search. The conceptual design will include gas processing to extract natural gas liquids in advance of the GTL section.

Elsewhere in Papua New Guinea, Rentech announced the signing of an MoU in June 2004 for the development of a pipeline and integrated methane complex including a 15,000 b/d GTL plant as its cornerstone. Participants in the MoU with Rentech are the PNG government (represented by the Ministry of Petroleum and Energy), Niugini Gas & Chemicals and I&G Venture Capital of South Korea. The participants will study the economic viability for the development of a natural gas pipeline to the northern city of Wewak and the construction of an integrated methane complex (IMC) at Wewak. The IMC is envisioned to include the production of LNG, CNG, ammonia and urea as well as the GTL facility. The study will include a total project assessment including: optimum pipeline utilisation for a northern pipeline; maximisation of developed and undeveloped PNG natural gas reserves; technical options of producing methane end products; product recommendations and market acceptance in the region; market off-takes; and all financing aspects for the project and project site.

● Indonesia

Feasibility studies for a GTL plant of 16,500 b/d in Indonesia were completed in 2002. Named the Matindok project, this has been advanced jointly by Rentech and Pertamina and the two companies are now working on funding issues.

● South America

Bolivia was the initial focus of interest for GTL projects in South America and feasibility studies have been completed for three plants. However, further developments await a new hydrocarbons law, which at presstime was being debated in the Senate following a referendum in July 2004 on the future of the country's gas reserves. As soon as the new legislation is enacted the projects will be re-evaluated to confirm their commercial viability.

The largest project is for a plant with a capacity of 90,000 b/d and is being promoted by Repsol-YPF and Ivanhoe Energy to use Syntroleum's technology. Repsol-YPF is also proposing a second plant of 13,500 b/d again with Syntroleum's technology. The former's output would be export-oriented while the latter would produce for the domestic market. The third project is proposed by GTL Bolivia using Rentech's technology with gas feedstock from the Itau Field operated by Total. This plant would have an initial capacity of 10,000 b/d with a view to expanding to 50,000 b/d. Feasibility studies and pre-FEED have been completed. The project developer, GTL Bolivia, is working with interested parties on funding to move to FEED and development

In Brazil, Petrobras has shown keen interest in GTL and in developing strategic partnerships with

companies which have the technologies. It has conducted preliminary studies for a small plant to be located in the Amazon region and also for a floating GTL plant to process associated gas and prevent flaring from some of its offshore fields.

Russia

Russia's interest in GTL was strongly signalled for the first time in a presentation by Gazprom's affiliate, Vniigaz, at the World Gas Conference in Tokyo in June 2003. The country has very large stranded gas resources and three months before WGC2003 Gazprom and Syntroleum had reached an agreement to carry out a preliminary investment analysis on 12 locations for GTL plants. The two have now selected four of the 12 sites for further engineering and project development. Syntroleum is in discussions with several potential development participants.

Blends of GTL fuel are currently being sold at Shell retail stations under the V-Power Diesel brand in Germany (pictured) and The Netherlands, as Pura Diesel in Thailand and Shell Diesel 2004 in Greece.

Egypt

While an Ivanhoe Energy proposal for a plant in Oman did not proceed due to a lack of sufficient uncommitted gas volumes, the company does have a good prospect in Egypt. A proposal for a 45,000 b/d plant is under consideration by the Egyptian government and its agencies responsible for the development and monetisation of the country's natural gas reserves. The alternatives of pipeline and LNG exports are also under evaluation

Other proposals

Large-scale GTL plants have been proposed in several other countries. Particularly significant are proposals by Iran to allocate part of planned production from large gas reserves in its offshore South Pars Field for the development of GTL projects. Proposals for projects involving Shell and Statoil/Petro SA as the foreign partners are reported to be suspended, but negotiations are underway for a 51,000 b/d plant at Asaluyeh to be operated by Iran's National Petrochemical Company (NPC) using Sasol's SPD technology. Additionally a feasibility study has been prepared by Narkangan GTL for a plant at Tombak with a capacity of between 10,000 and 30,000 b/d. The choice of a foreign partner's technology has not yet been made.

There is also renewed interest in using the F-T process with coal as a feedstock in countries with large coal reserves such as Australia, China and the US, but that is another story.

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

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Qatar to be a World Leader in GTL Production

By Gina Coleman

Ras Laffan in Qatar, the hydrocarbon-rich Arab Gulf State with a total population of just under three quarters of a million, is on its way to becoming the GTL capital of the world. Its first commercial plant is scheduled to start production in 2006 and five other plants are at different stages of negotiation or development, indicating that Qatar could be heading for production of over 800,000 b/d by 2015.

The country's expansion into GTL will open up additional markets for its enormous North Field – the world's largest single non-associated gas field with proven reserves in excess of 900 tcf (25 tcm). Qatar is already a major supplier of LNG and natural gas by pipeline, and also uses natural gas to generate electricity. State-owned Qatar Petroleum believes that the large-scale commercialisation of GTL production has a bright future as part of the diversification of the country's gas industry. GTL products can be stored and transported using conventional tankers and storage infrastructure. GTL plants will also provide the opportunity to produce higher value feedstock for other petrochemical industries in Qatar, such as polymers, fertilisers, dyes and paints.

Oryx GTL will be Qatar's first GTL plant.

"Green diesel", one of the most significant products to emerge from the GTL process, promises to reduce vehicle emissions significantly and has performed well in a series of trials around the world. Further boosting its market acceptance, the latest European Union directives will limit the amount of sulphur in all petrol and diesel to 10 parts per million by January 1, 2009, with a proviso that low-sulphur fuels should be available in the EU from January 1, 2005.

Oryx is the first

Qatar's first GTL project – Oryx GTL – is scheduled to start operations by the second quarter of 2006 and recruitment and training of Qatari nationals is underway. The project is a $900 million joint venture between Qatar Petroleum (51%) and Sasol (49%) and will use Sasol's SPD technology. Like all the country's GTL projects it is being developed in the northern industrial city of Ras Laffan.

The front-end engineering and design (FEED) was carried out by Foster Wheeler Energy, UK, while the engineering, procurement and construction (EPC) contract – which includes responsibility for the start-up and initial operation of the plant up to the performance test phase – was awarded to Technip-Coflexip of Italy. The construction phase is expected to be completed and commissioned by the end of 2005. Sasol Chief Executive, Pieter Cox, said: "In laying the foundation stone for the Oryx GTL plant at Ras Laffan, we [were] not just laying the foundation stone for a single plant, but for a whole new global industry. This venture will also set the performance and safety standards that will become a global benchmark as the GTL industry grows."

With a daily feedstock of 330 mcf (9.24 mcm) from the Al Khaleej gas project, Oryx GTL will have a capacity of 34,000 b/d – 24,000 b/d of diesel,

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In July 2004 the development and production sharing agreement for the Pearl GTL project was signed on behalf of Qatar Petroleum by HE Abdullah Bin Hamad Al-Attiyah, Second Deputy Prime Minister and Minister of Energy and Industry of Qatar (at right in the picture) and by Malcolm Brinded, Vice Chairman of the Committee of Managing Directors of the Royal Dutch/Shell Group and CEO, Shell Exploration & Production and Shell Gas & Power.

9000 b/d of naphtha and 1000 b/d of LPG. But even before its completion, there are already plans underway for expansion.

The original negotiations regarding Oryx GTL were started before Sasol and Chevron (now ChevronTexaco) formed their joint venture and that is why the partners for the first plant are Qatar Petroleum and Sasol. By the time expansion was on the cards Sasol Chevron had been set up and the proposed second and third plants will have the latter company and Qatar Petroleum as partners.

In March 2004 Qatar Petroleum and Sasol Chevron announced a plan to evaluate expansion of the project. This would involve the construction of a three-train, 65,000 b/d facility, with an expected start-up date of 2009. Plans have also been put forward to build a 130,000 b/d, six-train facility with a tentative start-up date of 2010. The expansion to three plants would take the total investment to around $6 billion.

Pearl on track

Shell has begun offshore operations to support Pearl GTL, a joint venture between Qatar Petroleum and Qatar Shell GTL Limited. The Pearl GTL project is a fully-integrated up and downstream project that will ultimately utilise 1.6 bcf (44.8 bcm) of gas per day to produce 140,000 b/d of GTL products, in addition to what company officials refer to as "significant" quantities of associated condensate and liquefied petroleum gas (LPG). The onshore complex will consist of both a traditional gas plant to treat the sour gas supply and a GTL plant. Initially, the gas plant will produce condensate and LPG (and later, ethane), as well as feed gas for the GTL plant, which will be developed in two phases. The first, to be operational by 2009, will produce around 70,000 b/d, while capacity will be doubled when the second phase is completed less than two years later.

Shell's offshore operations for Pearl GTL are in two designated blocks of the North Field and

involve two steel-jacket wellhead platforms (one for each phase of the project), which will accommodate multiple deviated development wells. Two 30-inch (76cm) pipelines – one of 52 kilometres, the other 64 kilometres – will carry the wellhead fluids ashore. The seismic campaign was completed in 2003 with appraisal wells drilled in February, August and September 2004. The first series of geo-technical site investigations at Ras Laffan has also taken place. Offshore FEED activities are on track and the onshore FEED contract was awarded to JGC in February 2004.

The Pearl GTL project is expected to create around 15,000 jobs during the construction phase and between 600 and 1000 jobs in the operational phase. Shell has also committed to be an anchor tenant for Qatar's new Science and Technology Park (STP), part of the Qatar Foundation for Education, Science and Community Development's Education City. The STP will encourage research and dialogue between industry and academia. GTL technology is expected to figure in the research activities.

● Marathon, ConocoPhillips and ExxonMobil sign up

Marathon Oil Company, a wholly owned subsidiary of Marathon Oil Corporation, is evaluating a GTL, LPG and condensate project using Syntroleum's technology under a Statement of Intent with Qatar Petroleum. Marathon's pre-FEED work was completed during the last quarter of 2003 and the company is considering introducing shareholders to the project, possibly to include PetroCanada, Mitsui/Mubadala, Occidental and the UAE Offsets Group. The project is expected to consist of two 60,000 b/d trains with first commercial production from phase one planned for 2010 and to be executed on a production sharing agreement basis. Offshore development would be based on two unmanned wellhead platforms.

In December 2003 ConocoPhillips and Qatar Petroleum signed a Statement of Intent initiating detailed technical and commercial pre-FEED studies and establishing principles for negotiating a Heads of Agreement (HOA) covering two 80,000 b/d GTL plants. The plants would use ConocoPhillips' COPox technology with first production anticipated in 2009-2010. The pre-FEED was completed in 2004 and announcement of the HOA was expected at presstime. The plant would be fully owned by ConocoPhillips.

Meanwhile, in July 2004 the Government of Qatar and ExxonMobil Qatar GTL Limited announced that they had entered into a HOA for a $7 billion GTL project at Ras Laffan. Using ExxonMobil's AGC-21 GTL technology, the plant would have a capacity of 154,000 b/d with approximately half of production being diesel, 20% high-quality lube base stocks, and the remainder naphtha and other associated products.

The HOA specifies the principal terms for the project that will be defined in a 25-year development and production sharing agreement, which would run from the start of production – expected to be in 2011. ExxonMobil's investment contribution will be 100% of the projected capital cost.

In a statement following the signing, Qatar Petroleum said: "ExxonMobil will design, construct and perform all petroleum operations in connection with the GTL project. This includes the rights to develop and produce gas, associated liquids and other hydrocarbons in sufficient quantities to meet the 154,000 b/d capacity of the GTL plant."

Given the active GTL plans of all these companies, Qatar's projected GTL production is likely to top 800,000 barrels per day within the next decade.

Gina Coleman is a broadcast and print journalist who has lived and worked in Qatar for the past 25 years. She writes extensively about the country and its industrial development for publications throughout the Middle East and Europe.

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The Lessons of Ghislenghien

By Bérénice Crabs

The safety record of gas transmission networks and of the LNG chain is excellent, and accidents involving loss of life are extremely rare. Nevertheless they do happen; an explosion in Belgium last year claimed the lives of 24 people and injured many more.

The next issue of the IGU Magazine will have an article looking at the methods used to minimise gas transmission risk to the general public. Here I would like to bring you up to date with respect to the Belgian tragedy, bearing in mind that a definitive report awaits the completion of the judicial enquiry.

On July 30, 2004, the transit pipeline from Zeebrugge to the Belgian-French border ruptured at a point where it passed through the town of Ghislenghien and the gas was ignited. The explosion killed 24 people, injured a further 131 and caused substantial damage. Before the disaster there had not been a fatal accident involving a natural gas transmission pipeline in western Europe since 1970[1]. Indeed Belgium had never had an accident on a natural gas transmission pipeline causing fatalities or injuries since the country introduced natural gas in 1967.

The affected pipeline was built in 1992 linking Zeebrugge to the French border over a distance of 145 kilometres in order to carry Norwegian gas to France. It is designed for a maximum operating pressure of 80 bar, has a diameter of 1000 mm and runs in parallel to a transport pipeline (providing gas to Belgian domestic and industrial consumers) with the same maximum operating pressure but with a diameter of 900 mm. Both are operated by Fluxys.

The accident happened on an industrial estate (built after the two pipelines had been laid) where

1 See statistics from the European Gas Pipeline Incident Data Group (www.egig.nl).

Ghislenghien was Belgium's first transmission accident causing fatalities or injuries since the country introduced natural gas in 1967.

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construction work on a road crossing the pipeline had been performed in the months preceding the accident. Evidence strongly suggests that the pipeline had been severely damaged by some heavy mechanical device prior to the accident. In the period during which the damage was probably inflicted the operating pressure inside the pipeline was around 60 bar, 25% less than the maximum operating pressure. On July 30, in the framework of planned and announced maintenance work at production platforms, the flows at the Belgian-French border were reduced. As a consequence, gas pressure in the pipeline rose to 70 bar (still considerably below the maximum operating pressure of 80 bar), which probably induced or increased a leak at the spot where the pipeline was weakened by the damage. Due to the severity and the amplitude of the damage, the leak developed into a full rupture of the pipe in a period of a few hours.

Current Belgian legislation prohibits every action that could adversely affect gas transport and contains extensive safety prescriptions, such as safety areas around pipelines. No building works are allowed within five metres of a pipeline. Legislation also provides for an advisory procedure, which involves local authorities (municipalities) and obliges any third party planning to carry out construction works closer than 15 metres to a transmission pipeline to inform the pipeline operator, who has to provide details of the exact position (particularly depth) of the pipeline.

In a second phase, the contractor has to submit details of the works around the pipeline to the operator. Before starting the works the contractor has to verify by hand digging the actual position of the pipeline and to take adequate measures to prevent damage to the pipeline. Furthermore, Directive 92/57/EEC of June 24, 1992 has been transposed in Belgian legislation requiring the appointment of a safety coordinator for construction works. The main task of this person is to ensure that all risk scenarios are assessed during conceptual engineering of the works, and that all contractors are informed of the results of this assessment during the works.

Apart from the human tragedy the explosion destroyed this factory.

Recommendations

The Ghislenghien accident occurred despite an adequate framework of safety legislation and a Fluxys prevention policy, which is more stringent than that imposed by the legislation. This is why, Fluxys believes, the challenge is to arrive at a correct application of the existing legislation and the simplification of procedures and interfaces between different stakeholders, rather than issuing new legislation.

An example of simplification could be the introduction of a statutory nationwide "one call" system for reporting works. This would considerably reduce the time-span between the information request by the third party and the pipeline localisation by Fluxys at the construction site.

Training programmes and actions aiming at raising awareness and know-how of the construction industry and fire-fighters as well as actions regarding legislation covering safety coordinators would also help reduce the chances of a Ghislenghien-like disaster happening again.

Bérénice Crabs is External Communication Advisor, Special Projects of Fluxys.

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R&D in the Gas Chain: There is no Future without Technological Innovation

By Erich Jurdík & Roy M. Bilbé

Research and development and technological innovation in the gas chain are under enormous pressure just as the gas sector faces massive strategic challenges.

The demand for gas is likely to double within the next 30 years and global competition will increase rapidly. Concerns over ensuring long-term security of supply, the need for increased transparency in safety management, the drive for further increases in efficiency of gas utilisation, the reduction of emissions and the necessity for operational cost savings are just a few examples of issues currently on the corporate agenda. All have a direct link to technological expertise and addressing them means enforcing the link between R&D and strategic business needs. Such an approach requires short-, medium- and long-term actions and a commitment to technical innovation. However, the general corporate trend is to cut costs wherever possible, in particular R&D, and to focus increasingly on short-term issues. Over the longer term there is a significant danger that such a policy will hamper successful business development in the gas sector.

IGU has recognised the need to address this issue and has constituted a Task Force to advise on technology policy. The objective is to provide guidelines to policymakers and to encourage the right business decisions.

Effects of liberalisation

Over the last few years news of cuts in R&D expenditure made by gas companies in developed gas market countries has been frequent. This trend is undoubtedly due in part to liberalisation of the energy market, which has been progressing steadily in many countries. However, liberalisation in itself is not the only reason; the culture in the sector is such that industry is not investing enough in R&D.

The major challenges the energy sector faces might become true obstacles to economic development and human welfare, if not tackled in time. Let us now outline a number of them.

Challenges, which are of truly global interest, include scarcity of primary energy resources, growing demand for energy and the issues of security of supply. In particular, the largest energy consumers, which include the developed nations of Japan and those in North America and the European Union, must be concerned. In addition, there are growing environmental issues. Emissions of gases, such as hydrocarbons and carbon dioxide, can potentially cause global climate problems that will have an effect across all continents. Local emissions, such as oxides of nitrogen or sulphur, must also be dealt with. And while these problems are talked about, is sufficient actually being done on governmental and corporate levels to tackle them?

At present it seems that the discussion concentrates on financial benefits for the end-consumer. It is from here that the liberalisation process is being pursued. However, this process, whilst delivering many short-term benefits, has had dramatic consequences for the R&D situation in the energy sector. This is especially so in the United Kingdom and the United States, where liberalisation is most advanced and negative effects on R&D are clearly visible.

United Kingdom

Before market liberalisation and the introduction of competition in gas supply in the UK, that is prior to 1993, British Gas – then an integrated gas monopoly – spent around £90 million per annum on R&D. By 2003, a decade after liberalisation, the combined R&D spend of the successor companies, BG plc, National Grid Transco and Centrica, on gas-related R&D had fallen by over 75% to below

£20 million. These are current money values so the reduction is even more significant in real terms.

United States

At the end of 2004 the most substantial gas R&D funding mechanism in the US, the per-decatherm surcharge applied to the transfer of natural gas from the pipeline company to the user, ceased under the terms of a settlement reached between the natural gas transmission pipeline operators and the Federal Energy Regulatory Commission (FERC). The funds generated by this surcharge, which reached as high as $220 million in the late 1980s, were administered latterly by the Gas Technology Institute (GTI), formed in 2000 by the merger of the Gas Research Institute and the Institute of Gas Technology. In 2004 the total approved FERC funds budget for GTI was $60 million, covering all three gas segments – production, transmission and distribution.

Public service obligation

Of course, it is extremely difficult, if not completely impossible, to generalise these trends since each company, regulator and government has their own goals and targets, and thus behaves differently. To contrast the UK and US experiences with a brighter and more positive example, let us now have a look at another country where natural gas plays an important role – Denmark.

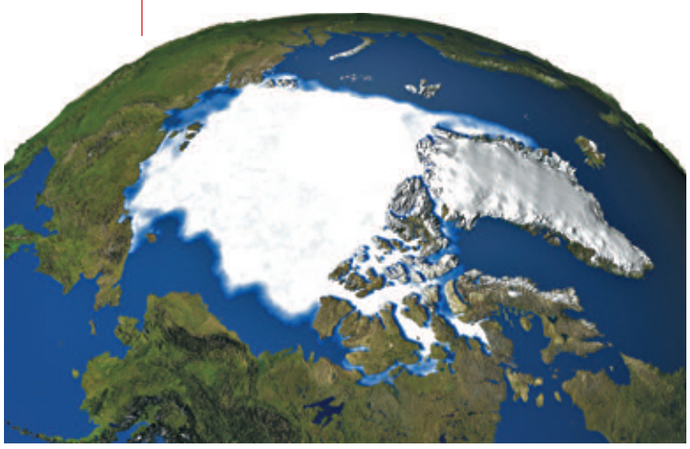
NATURAL GAS: SUPPLY VERSUS DEMAND

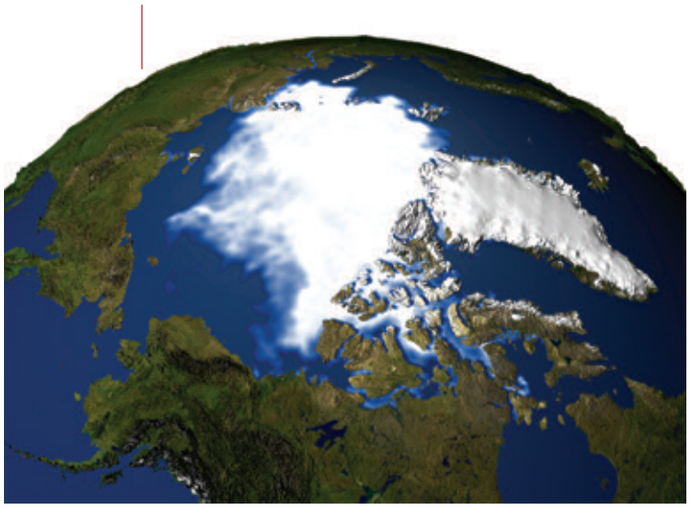
White: population centres, where the lights are on, satellite image

In the future natural gas will have to bridge large distances to get from regions where it is produced to centres of demand. Issues that concern operational cost management (pipelines, LNG installations and transport, etc.) and implementation of "new" gases (being natural gas and LNG from other locations as well as biogas and possibly hydrogen) in the existing infrastructure, to name only two examples, can be resolved by dedicated and focused research and technology development.

As Lord Browne, Group Chief Executive BP, pointed out (*Fundamentals of World Gas Industry,* 2003): "Connecting gas to customers is the challenge. And here the news is good. Upstream costs have been falling at roughly 2.5% a year since 1989 driven by competition and new technology. Even better, the cost of gas liquefaction and consequently the investment costs of the LNG supply chain have fallen spectacularly."

New technology helps to make energy accessible to a larger public at reasonable cost and in a safe and environmentally acceptable way.





These images, constructed from satellite data, compare Arctic sea ice concentrations in the Septembers of 1979 (TOP) and 2003 (ABOVE). September is the month in which sea ice is at its yearly minimum and 1979 marks the first year that data of this kind became available in meaningful form. The lowest concentration of sea ice on record was in September 2002.

The fact that natural gas is the least carbonaceous fossil fuel means that it has the lowest emissions of greenhouse gases per unit of energy used. The properties of natural gas make it an ideal candidate to mitigate environmental challenges and form a bridge towards a sustainable energy system.

The Danish government, after having observed that the R&D level in the gas chain had been heavily reduced as a consequence of liberalisation in some countries, specifically mentioned the need for R&D in the country's new gas law, making R&D a public service obligation. At the same time paragraphs were added dealing with mandatory consulting on energy efficiency that is to be given by gas companies to large customers. All these obligations rest with gas transporters, both transmission and distribution companies.

The costs can be included in the transportation tariffs and thus all gas users pay their share of these costs. The R&D clause in the Danish Gas Supply Act is formulated so that the Minister can intervene, if he or she deems it necessary.

What is the future of R&D?

The approach followed in Denmark might provide us with a key to assure long-term perspectives for energy technologies in general and those in the gas chain in particular. Indeed, it might be worthwhile for policy-makers in other countries to think about the potential benefits of such an approach. In the meantime, however, our fear remains; R&D in the gas chain is in danger and might even completely cease to exist (at corporate level).

The important role research and technology development played in the gas sector in the past is indisputable. Today, natural gas plays a prominent role in our energy system. The share of natural gas in the world total primary energy supply (TPES) is steadily increasing. In 2000 natural gas accounted for about 21.1% of the TPES and in 2030 this figure is expected to reach 25.8%. Taking into account the fact that the TPES is estimated to increase from 9963 to 16,300 million tonnes of oil equivalent (mtoe) over the same period of time, the volume of the gas market will double over the next 30 years. The gas industry is aware of its growing significance and must help to meet this increasing demand for energy through innovation. Development of novel technologies across the whole gas chain is necessary to react to the challenges in the most successful way possible in order to support global economic expansion over the coming decades.

We heard the voices of industry captains at the last World Gas Conference held in Tokyo in 2003. Here is what one of them, Lee R. Raymond, Chairman and CEO of ExxonMobil, had to say about innovation and technology: "Our industry's best years lie ahead – surpassing even the greatest achievements of the century gone by – a future

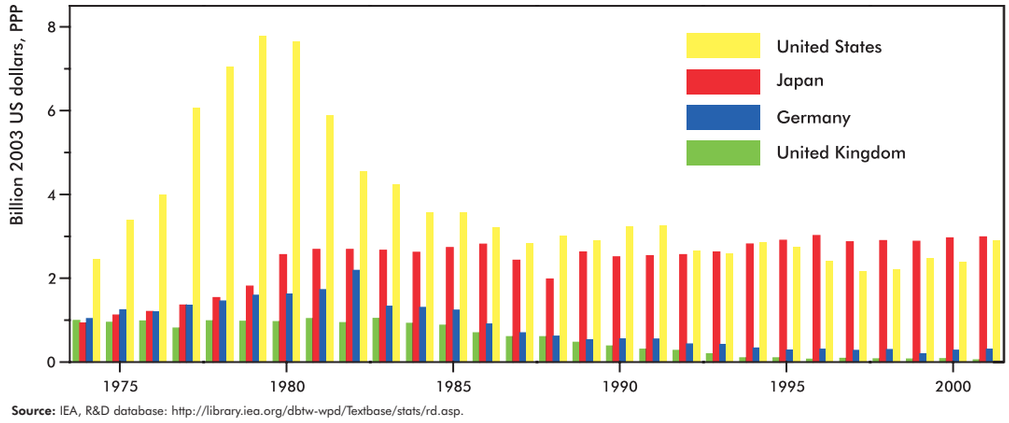
in which innovation, technology, performance and integrity will be absolute prerequisites for success. In our increasingly global enterprise, as political barriers give way to economic progress, the petroleum industry will continue to lead the way."

Why is it then that gas chain R&D remains a subject of discussion at company level and that the pressure to save costs by cutting R&D expenditure slowly but steadily becomes irresistible? What is the effect of such a business environment on the motivation of R&D staff to pursue their ideas and technological innovation? And how does this all fit into the picture of governmental strategies that aim at a secure and sustainable energy system, innovation and technology leadership? The answers are, as yet, not clear to us. In the gas chain it seems as if the talk was talked, but the walk was not walked. Assuredly, this statement could be generalised to the whole energy sector. What, then, is the future of our industry?

On the corporate level there are daily operations to be continued to ensure secure and safe energy delivery and, at the same time, organisational problems to be solved that are due to liberalisation. There is thus understandably only limited room for technological innovation.

In the meantime, governments could take on the responsibility of stimulating R&D in the whole energy sector and therewith assure a durable transition to a liberalised market and a sustainable energy system. Unfortunately public energy R&D expenditure is being reduced in nations that have had traditionally very strong energy R&D programmes. From 1980, when public energy R&D peaked at $7.6 billion in the United States (purchasing power parity in 2003 US dollars), it reduced to $2.8 billion in 2003. Strong European economies, particularly the United Kingdom and Germany, are doing even worse. At the same time, Japanese public energy R&D expenditure rose dramatically from 1974, although only very slightly during the last decade. We note here that the importance of R&D in Japan is generally accepted (also in the gas sector) and that Japanese gas-related R&D is traditionally very strong. The level and system of financing energy R&D is also, however, a topic of discussion in Japan as a consequence of the recent market adaptations. (*See Figures 1 & 2*)

Truly, it seems that neither the industry nor the governments are taking their responsibility for the future of the energy system too seriously. R&D budgets are being reduced along the whole chain. There is a clear shift towards short-term (business)



Source: IEA, R&D database: http://library.iea.org/dbtw-wpd/Textbase/stats/rd.asp.

Figure 1 shows the evolution of governmental energy R&D budgets (in billions of 2003 US dollars and purchasing power parity) for selected countries in the period 1974 to 2001.

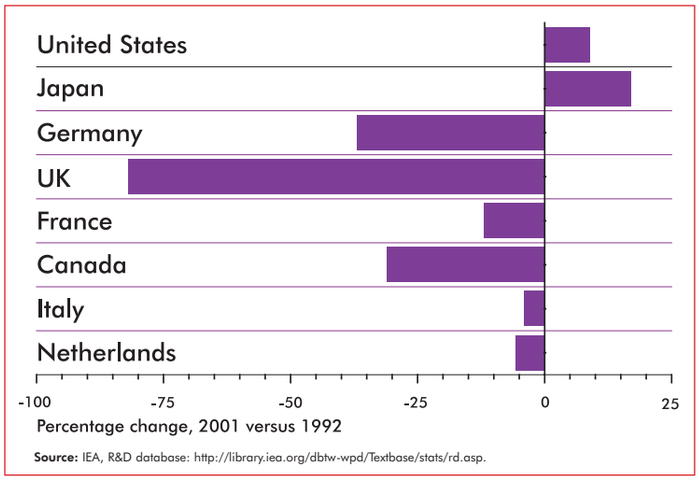


Figure 2 illustrates the percentage change in governmental energy R&D budgets for selected countries: 2001 versus 1992. The total estimated OECD budget remained roughly unchanged at about $8.2 billion (2003, PPP).

targets, at the expense of long-term strategy. But survival and raising profits today do not assure us of a better future.

Let us now turn briefly to the triennial International Gas Research Conference (IGRC) – the largest global R&D event in the gas chain. The trend in the number of submitted papers to this conference (see *Figure 3*) demonstrates the general evolution of gas-related R&D. While in 2001 some 408 papers were submitted, in 2004 this number decreased to 286 – a drop of 30% that most likely cannot be by chance only.

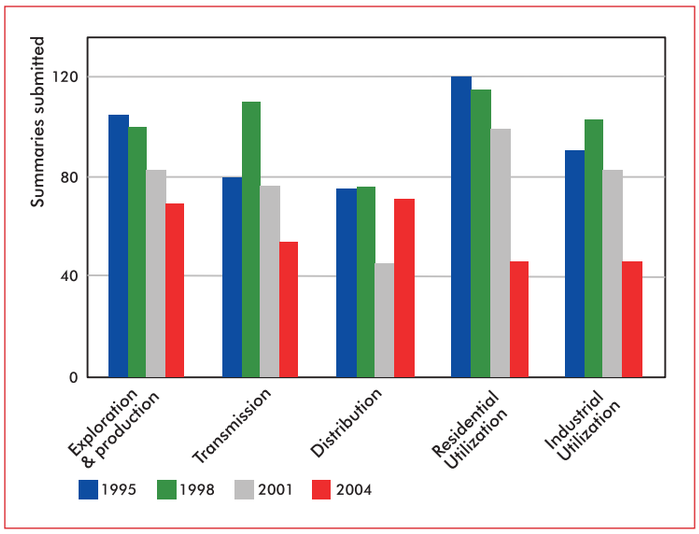


Figure 3 gives statistics for papers submitted to the last four IGRCs. The total number of papers submitted was 480 in 1995, increasing to 542 in 1998 and decreasing to 408 in 2001. Finally, the last conference held in November 2004 in Vancouver showed a dramatic drop to only 286 submitted papers.

Is there any hope of preserving the high level and quality of R&D that the gas chain was so proud of? What will be the role of our industry in the future? Will we be talking on a strategic level about the challenges the gas sector faces or will we turn toward actions to mitigate them? And how will governments take their responsibility in assuring a secure, efficient, accessible and environmentally friendly energy? The true answers will have to await developments in the near future. However, a scenario relying solely on market forces would put a lot at stake since it does not necessarily assure continuity of knowledge. In the face of the recent changes, no company and no nation can rest on its laurels since new ideas and technologies are not only desirable, they are essential.

The natural gas industry is a long-term business that needs R&D. The R&D task force of International Gas Union is helping to identify and prioritise the key technological developments to help the industry achieve its future goals and to ensure the R&D issues are given sufficient corporate air time and debate at the upcoming World Gas Conference in Amsterdam in 2006.

As a flexible and clean fuel natural gas has a vital role to play in the future energy infrastructure. A successful handling of the gas chain's R&D issues will ensure that this role is fully developed to the benefit of all stakeholders.

Dr Erich Jurdík is Research Scientist and Dr Roy M. Bilbé is General Manager R&D at Gasunie Engineering & Technology, NV Nederlandse Gasunie, Groningen, The Netherlands. Dr Bilbé is the Chairman of IGU's R&D Task Force, while Dr Jurdik is a member.

Slovenský Plynárenský Priemysel, a.s.

The gas industry has constituted a part of Slovak history for almost 150 years, and with the country's entry into the EU (May 2004), the Slovak gas market is swiftly adapting to a market economy. Slovenský Plynárenský Priemysel (SPP) has a long tradition in the natural gas market, and it possesses a portfolio of quality and reliable services and know-how in technical and technological fields.

SPP secures the failure-free supply of natural gas to domestic and foreign consumers. It sells in excess of 7 billion cubic metres of natural gas a year to more than 1.4 million customers. From a European perspective, Slovakia is of great importance, especially in terms of the transit of gas. The transit pipelines of SPP have been part of the international transmission network for more than three decades. Thanks to its gas transit network and strategic position between Russia and western Europe, SPP is the largest carrier of natural gas in the EU.

Entry to the EU has brought new business opportunities, as well as new energy legislation and new regulation in the field of energy. Slovakia has successfully adopted it, and SPP is preparing to operate in a liberalised gas market primarily by introducing a new strategy that focuses on the customer. Today, it is undergoing restructuring in order to increase effectiveness, transparency and competitiveness. A priority of the company is to improve and expand the portfolio of services and to satisfy the needs and wishes of its customers. SPP is developing its sales activities also in other related energy sectors with the aim of supporting sales of natural gas. SPP wants to be the best supplier of natural gas in the country, and in terms of international carriage it plans to maintain its significant position as a reliable carrier of Russian gas to the world.

The Global ICT Congress Comes to Asia

By Mark Blacklock and Jong-Sool Kim

Information and Communication Technology (ICT) is an integral part of the energy business and there is a clear need for a forum to bring the stakeholders from both the ICT and the energy industries together. This is the role of IGU's Global ICT Congress, which started as a symposium in 1987 and is held every three years.

The 7th Global Congress on Information and Communication Technology in Energy, ICT2005 for short, is being hosted by the Korea Gas Union, May 23-25, in Busan, Korea. This 7th Congress, with the support of the World Energy Council (WEC) and World Petroleum Congress (WPC), is the first in the series to broaden its scope from gas to the whole energy industry. This broadening in scope was a key recommendation of the last event, which was held in April 2002.

ICT2002 was hosted by the Czech Gas Association in Prague, Czech Republic. According to Olga Solařiková, Secretary General of the Association, the event attracted 393 delegates from 31 countries, while there were 16 exhibitors at the accompanying exhibition.

Taking over the baton, the Koreans are determined to build on the successful record of the Czechs. "We are honoured to be the first Asian country to host the ICT Congress and look forward to welcoming delegates from around the world," says Seung-Hwan Lee, Chairman of the National Organising Committee and a member of IGU's ICT Task Force.

"ICT2005 in Korea has special meaning in that it is the first such congress to be hosted in Asia, where some countries are playing the strong role in

The Busan Exhibition and Conference Centre (BEXCO) will be the venue for ICT2005.

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IT," continues Lee. "At the same time, this event will be an important momentum to serve as a catalyst for the future development of the energy technology that will keep improving the business at a time of such significant change for the energy industry.

"We expect that over 500 participants will partake in the event," says Lee. He adds that the notable participation of Asian countries is expected compared with the past congress. Only 19 Asians joined ICT2002.

The IGU ICT Task Force team, chaired by Véronique Durand-Charlot of Gaz de France, has produced an interesting technical programme around three major issues and three streams, and has also introduced a new CEO Forum.

Congress programme

ICT2005's main theme is "Value Creation with ICT in Energy Companies". Under this theme, the Congress addresses three hot business issues: competing in a deregulated environment; risk management; and reducing costs and improving performance. The streams are: upstream and midstream; downstream; and corporate functions.

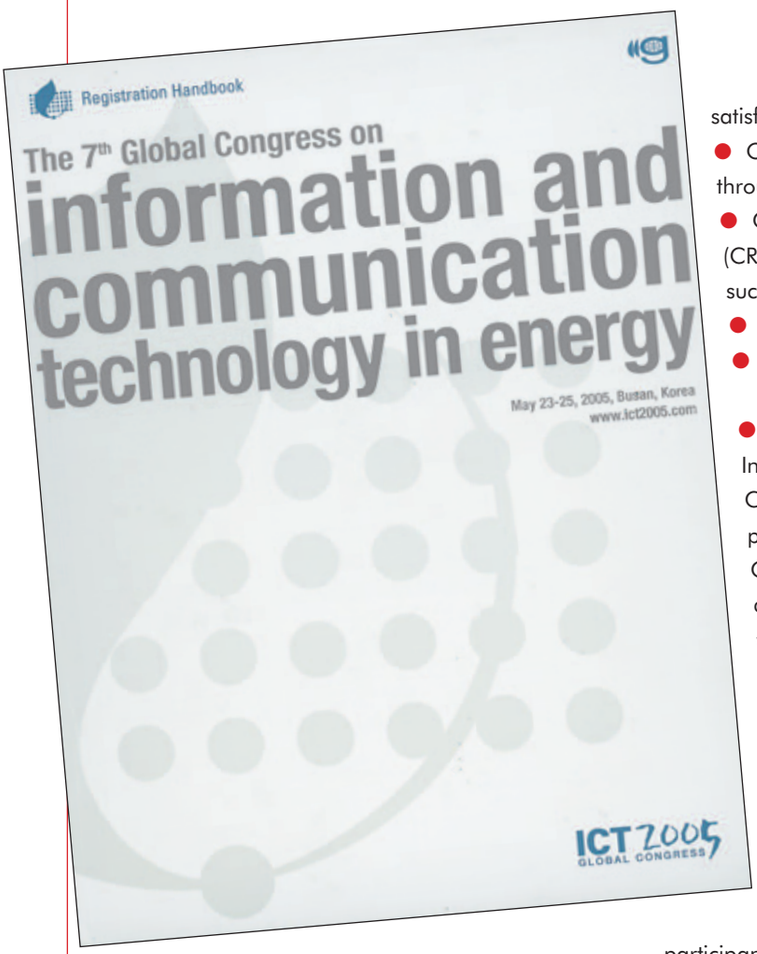
Keynote speeches will introduce each morning and afternoon programme (with the exception of the afternoon of day two, which is dedicated to a poster session). Keynote speakers include Jong-yong Yun, Vice Chairman & CEO of Samsung Electronics, Clive Mather, President & CEO of Shell Canada and Henk G. Dijkgraaf, CEO of Gasunie.

The programme will feature 14 paper and one poster sessions, and session topics include:

Competing in a deregulated environment

- A new paradigm for deregulated utilities: The client is the king.
- The implication of mergers and acquisitions for corporate ICT strategy.

With 3.7 million inhabitants Busan is Korea's second city and major port.



ICT2005 will give participants a unique opportunity to discuss and exchange ideas on ICT in energy.

- Data exchange regulation as a consequence of market deregulation.
- The strategic dilemma: Gaining ICT agility versus shaping the market.

Risk management

- In the post-Enron era, are you ready to cope with the new business framework?
- ICT, a breach in corporate security?
- Minimising supply disruptions and risks of failure.
- Conducting trading operations with responsiveness.

Reducing costs and improving performance

- Balancing operation costs and customer satisfaction.
- Operations productivity improvement through ICT.
- Customer relationship management (CRM) after the hype, feedback for a successful second wave.
- ICT sourcing.
- Successful ICT management models.

New CEO Forum

In addition to the technical programme the Congress will have a CEO Forum, where participants will have a chance to hear CEOs of leading energy and IT businesses discussing their vision of value creation with ICT. The Forum will be on the afternoon of May 23, the first day of the Congress, and CEOs from companies such as Gasunie, Gaz de France, Korea Gas Corporation (KOGAS) and Shell Canada will attend.

Along with the Congress and the accompanying exhibition, varied and attractive programmes will entertain participants of ICT2005. The National Organising Committee (NOC) has organised tours of attractions in Korea, which will provide a real chance to look around the country's famous and beautiful sites. In addition, the NOC will provide a pre-Congress city tour of Busan and a technical visit to Tongyong LNG receiving terminal on the last day of the Congress.

Lee recently announced that there are still some platinum, gold, silver and bronze sponsorships available and interested companies may contact the Congress Secretariat.

Mark Blacklock is the Editor-in-Chief of International Systems and Communications. Jong-Sool Kim is the Secretary General of the Korea Gas Union. Readers requiring more information on ICT2005 are directed to the website www.ict2005.com.

Czech Gas Association

The Czech Republic is one of the most important European countries that transport natural gas. The country started building this position 35 years ago when, in December 1970, Czechoslovakia and the Soviet Union signed an agreement on natural gas transit transmission. Two years from that moment, natural gas transport to Austria, and on the last day of the following year to Germany (both German republics), began. Over the years, a gas transmission capacity of almost 60 bcm/year has been developed across the Czech Republic.

The development of the transit transmission gas pipeline has also helped to significantly improve the conditions for introducing natural gas in the Czech Republic itself. Once natural gas supplies started flowing in, a process of converting all customers from town gas to natural gas was launched; it was followed by massive connections to natural gas supplies in areas where the conversion had been completed. As a result, almost 70% of all households are connected to natural gas supplies at present; natural gas has also become the most important fuel used for heating purposes. Almost one-third of Czech households enjoy the benefits of having their own natural gas heating systems.

To underpin the further development of the Czech gas industry, a strategic partner had to be found. The German company RWE emerged as the winner from the bidding competition; in several steps, it has acquired the entire equity interest in Transgas, a.s. (which provides for the transit transmission of natural gas and imports natural gas into the Czech Republic), majority interests in six regional gas distribution companies, and significant interests in two gas distribution companies. Major energy and gas companies, for example E.ON, Wintershall, VNG, SPP a.s., SPP Bohemia a.s. and Ferngas, as well as municipalities and retail investors are the other owners of distribution companies. These Transgas and gas distribution company shareholders rank among important members of the Czech Gas Association.

The process of the Czech gas industry's restructuring in line with the EU's gas directive has started. A healthy and competitive environment in the energy sector should be the result of the restructuring in the electricity and gas industries. We hope that this may also help to reinforce the gas industry's position in the Czech energy market.

Joining IGU as an Associate Member

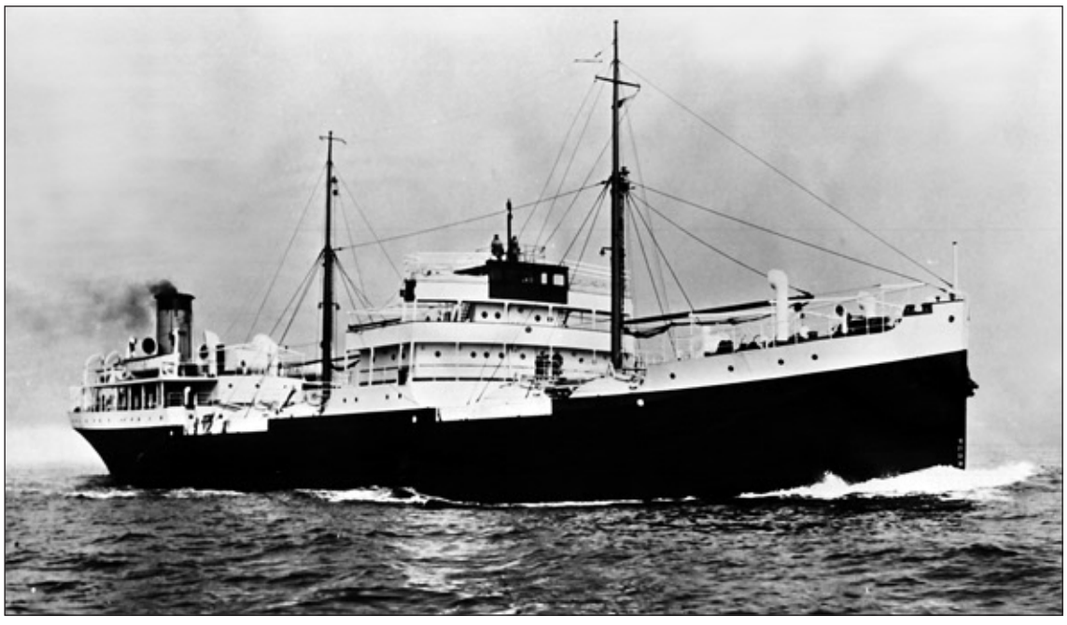
By Mark Blacklock

As soon as companies could join IGU as Associate Members Shell did not waste time with its application, which was approved by the Council in May 2003. According to Knud Petersen it was not just "an honour and a great opportunity, it was an obvious thing to do".

Petersen is General Manager Commercial & Technical Advice for Shell Gas & Power International BV, the company in the Royal Dutch/Shell Group that holds IGU Associate membership. This Dutch-registered company took over the role from the UK-registered Shell International Gas Limited in September 2004.

Gas & Power is one of Shell's four core businesses (the others being Exploration and Production, Oil Products and Chemicals) operating downstream to process and transport natural gas, develop power plants and market gas and electricity to customers around the world. Shell Gas & Power has operations in over 30 countries and an active portfolio of development opportunities globally.

According to Petersen the restructuring of the gas industry, particularly in Europe, makes it important for the gas divisions of oil and gas majors to increase their participation in IGU by having direct membership as well as involvement via the national Charter Member. It is one of the



Shell has been involved in the natural gas business from its earliest days, developing gas fields and transport systems including the world's first LPG tanker and the first purpose-built LNG tankers.

The first ship to be fitted with special tanks to carry LPG was the *Agnita* (ABOVE). Built by R & W Hawthorn Leslie in Hebburn-on-Tyne, UK, the *Agnita* was launched in 1931 and was operated by Shell's transport arm, which was then called the Anglo Saxon Petroleum Company.

The first trials in shipping LNG started in 1959 and were carried out by Constock International Methane using a converted cargo vessel called the *Methane Pioneer*. The following year Shell acquired a 40% stake in the company, renamed Conch International Methane, and the Conch aluminium tank design was used in two purpose-built tankers to be operated by Shell – the *Methane Princess* and the *Methane Progress*. Each tanker had a capacity of 27,400 cubic metres and the *Methane Princess* transported the first commercial cargo of LNG in October 1964 (see page 114).

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Shell's newest LNG tanker is the *Gemmata*, which has a capacity of 135,000 cubic metres and was delivered in January 2004. The *Gemmata* uses Moss Rosenberg nickel steel tanks and was built by Mitsubishi Heavy Industries in Nagasaki, Japan.

ways of developing and maintaining contacts with all the new enterprises in the gas industry, and also a means of having a voice in its continuing evolution.

"IGU is a well-run, diverse organisation that provides an excellent forum for the exchange of ideas," Petersen says, "but it needs active engagement. As a company we are involved in the Special Project on Gas to Power and personally I am active in Programme Committee B (Strategy, Economics and Regulation), while we also make ad hoc contributions to other IGU activities."

Shell staff also play a role in IGU through their national Charter Members, notably on Programme Committee D (LNG) of which Robert Klein Nagelvoort from The Netherlands (Shell Global Solutions) and Saleem Piracha from Pakistan (Shell Pakistan) are members.

Gas to Power

Shell has been involved from the beginning in the series of Gas to Power workshops that are engaging governments, industry and other stakeholders in a dialogue on the potential for, and the obstacles to, the use of gas in power generation. The first workshop was hosted by the Brazilian Institute of Oil and Gas in Rio de Janeiro on April 29, 2004, and was scheduled immediately after the 4th Latin American and Caribbean Gas and Electricity Conference.

This was followed by a joint IGU/International Energy Agency workshop "The Future of Gas for Power Generation", which was held at IEA headquarters in Paris on June 14. James Nyhan, General Manager Business Development Shell Energy Europe (the part of Gas & Power that conducts operations, sales and marketing of gas and electricity in European markets) gave a paper on "Supplying Gas to Europe and the Role of Power Generation".

A third workshop was held in Brussels on October 4.

Recommended

Petersen points out that when the cost of staff time and other resources are added to the basic membership fee, Associate membership represents a sizeable investment but says it is "money well spent". He urges other gas companies to join the existing 18 Associate Members and make their voices heard in the Union.

Mark Blacklock is the Editor-in-Chief of International Systems and Communications. For more information on Shell see www.shell.com.

Preserving the Gas Industry's Heritage

By Hanne Thomsen

The gas industry has an exciting future, but as well as looking forward to new challenges it is important to preserve our heritage. This is why we have launched a project to help preserve the history of gas for the future by developing a special website. The aim is to integrate gas museums and collections worldwide into a virtual network and provide information to the general public.

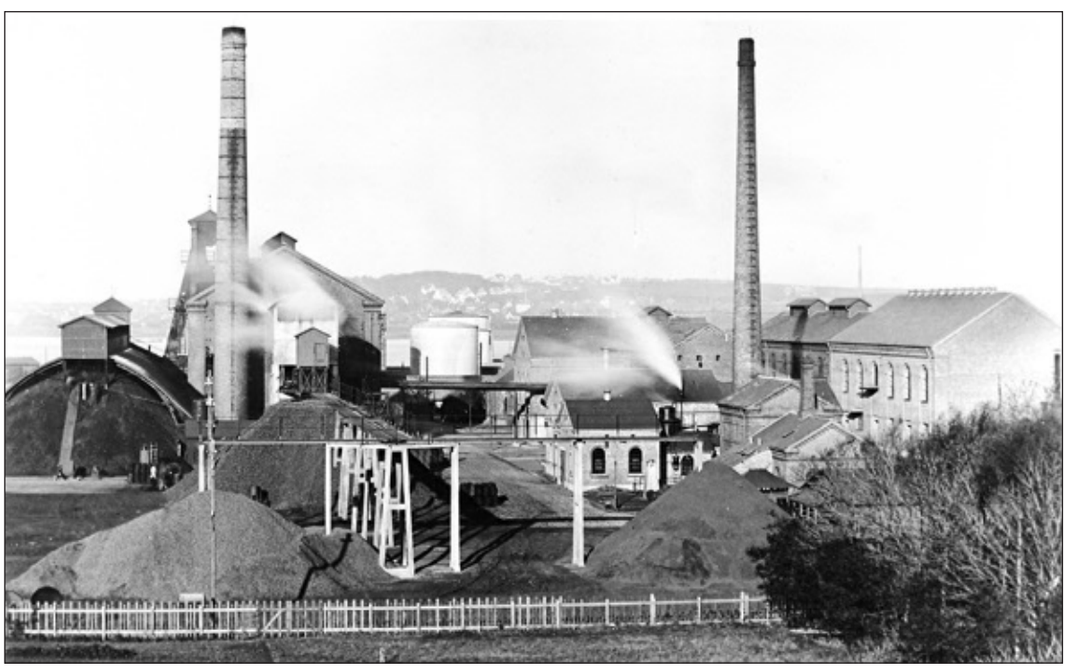
At this time of liberalisation and restructuring in the industry it is essential to preserve the history of gas, including collections and archives, for the future.

Website and exhibition

So far we have had very positive responses from many parts of the world. Our plan is to create a joint website with links to project partners within the IGU framework. We are also planning to mount a small exhibition about the history of gas at the World Gas Conference in Amsterdam in 2006, and we invite everybody to contribute posters or objects to the exhibition. Please inform the project's task force about possible contributions. The project leader is Jacob Fentz, International Coordinator at Naturgas Midtnord.

More information wanted

Gas museums and collections can be found in several places around the world. One of them is the Danish Gas Museum described below, and we would like to encourage others to talk about their museums and about possible plans and initiatives. These contributions could be the starting point for a website dedicated to the historical development of gas. Please email plans and ideas to gasgas2@image.dk.



Aalborg's first gasworks was built in 1854 and it was one of the first in Denmark. In 1903 the Danish Gas Company, which owned the gasworks until the municipality took it over in 1911, moved out of town and built a new plant (pictured).

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The Danish Gas Museum opened at its present site in Hobro in 1998. See www.gasmuseet.dk for more information.

The Danish Gas Museum

Denmark's first gas museum was started 10 years ago by the employees at Hovedstadsregionens Naturgas, the company with the biggest coal gasworks in the country whose customers changed to natural gas from the mid-1980s. In this connection the employees collected relevant objects to make an exhibition including objects from the archives of the coal gasworks.

The Gas Museum now has exhibitions about the use of coal gas in industry and in private homes, about bottled gas, which became widely used from the end of the 1940s, and about natural gas from the North Sea. At the moment we are working on an exhibition in 2006/07 about piped gas, i.e. mainly the history of coal gasworks and natural gas. The museum is still collecting items, but it already has a fine collection concerning the production and the use of gas. It is just now quite easy to collect objects in connection with the conversion to natural gas, which is being carried out in parts of Copenhagen.

Danish gas history

The era of gas started relatively late in Denmark. The first coal gasworks was established in 1853, but Copenhagen, the capital, was not supplied with gas until 1857. Some 112 gasworks were built during the period until 1916.

When the first signs of crisis appeared for labour-intensive coal gas production in the 1950s, a move began to switch to the less demanding fission gas or propane gas. As a consequence of rising oil prices after the oil crises in the 1970s these processes became too costly compared with other energy sources, and nearly all gasworks were shut down before the introduction of natural gas was decided upon. The gasworks in Aalborg is an exception, and it and its predecessor have distributed gas – now natural gas mixed with air (town gas) – for 150 years.

Hanne Thomsen is the Director of the Danish Gas Museum and can be contacted at gasgas2@image.dk. Project leader Jacob Fentz can be contacted at jaf@midtmord.dk.

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.)

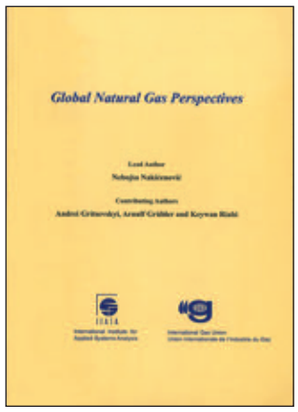
2003-2006 Programme

- Strategic Guidelines as approved by the IGU Executive Committee in Tatranska Lomnica on April 10, 2003, (4 pages)*.
- Triennial Work Programme as approved by the IGU Executive Committee in Cape Town on October 28, 2003, (59 pages)*.
- Summary of Triennial Work Programme, (14 pages).
- TWP 2003-2006 session on the 22nd World Gas Conference 2003, (DVD and video).
- Exhibition WGC 2006, leaflet introducing the World Gas Exhibition in Amsterdam, (3 pages).

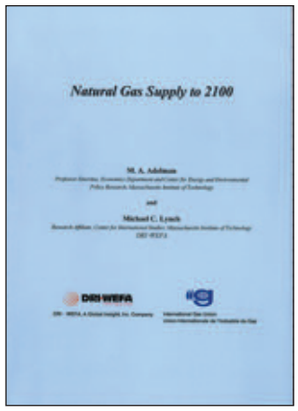
2000-2003 Programme

- Triennium 2000-2003, TCC Final report, IGU October 2003, (132 pages).
- Triennium 2000-2003, NOC Final report, IGU October 2003, (30 pages).
- 22nd World Gas Conference Tokyo 2003, (DVD).

Scientific and technical papers and documentation



- Global Natural Gas Perspectives, Nebojša Nakićenović e.o., IIASA, IGU, October 2000 (71 pages 18 x 25.7cm). 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.



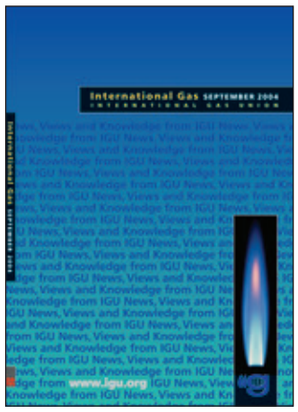
- Natural Gas Supply to 2100, M. A. Adelman and Michael C. Lynch, DRI-WEFA, IGU, October 2002 (51 pages 18 x 25.7 cm). This booklet outlines the authors' assessment of a long-term supply curve for natural gas using recent estimates of costs and known reserves.

- Seven Decades with IGU, ISC 2003, (186 pages). IGU's 70th anniversary fell in 2001 and at the next World Gas Conference in 2003 this book was launched containing

articles on the organisation's history as well as on current and future issues facing the international gas industry.

- Proceedings of the 20th World Gas Conference, Copenhagen 1997, (CD Rom).
- Proceedings of the 21st World Gas Conference, Nice 2000, (CD Rom).
- Proceedings of the 22nd World Gas Conference, Tokyo 2003, (2 CD Roms).

- IGU Triennium 2000-2003 WOC 2 Basic activity study, Worldwide UGS Database, (CD Rom)**.
- International Gas, ISC September 2004 (128 pages). The second issue of the IGU Magazine.

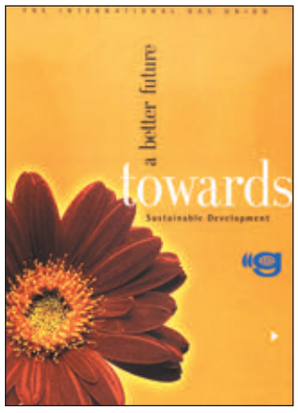


IGU organisational information

- IGU Articles of Association, as approved by the IGU Council September 18, 2002, (28 pages A5).
- IGU Guiding Principles for Sustainable Development, October 2003, (12 pages A5). This leaflet contains the recently updated and approved recommendations to IGU Members and the global gas industry regarding responsible behaviour in this context.

- News, Views and Knowledge on Gas – worldwide, (3 pages). This general brochure gives a concise introduction to the organisation together with its Vision and Mission.

- A Better Future Towards Sustainable Development, (5 pages). This brochure highlights IGU's position in promoting natural gas as a part of the solution to climate change.



- IGU Organisation Chart 2003-2006, (3 pages).

* Can also be downloaded from the IGU website

** Can also be downloaded from the IGU collaboration portal

The publications, brochures, DVDs and CD Roms can be ordered (as long as available) from:

The IGU Secretariat
P. O. Box 550
c/o DONG A/S
Agern Allé 24-26
DK-2970 Hørsholm
Denmark

Tel: +45 45 17 12 00
Fax: +45 45 17 19 00
E-mail: secr.igu@dong.dk
or from the Coordination Committee Secretariat

Opinion Page

This is a new column giving readers the opportunity to air their opinions about current issues in the gas world. The exchange of information is at the heart of all IGU's activities and our aim here is to create an additional and less formal forum for debate, with contributors free to express personal views that do not necessarily reflect the official policies of IGU or the organisations they work for.

Tjerk Veenstra starts the ball rolling in this issue and we hope you will be inspired to join in. You can contact him direct with your reactions (t.veenstra@gasunie.nl) or via the Editor (mark@intscltd.demon.co.uk). Tjerk Veenstra is Senior Advisor on HSE and Sustainability at Gasunie-Gas Transport Services and is a member of IGU Programme Committee A on Sustainability.

Clean, cleaner, cleanest

In discussions on the reduction of global warming and the abatement of greenhouse gases from fossil fuels there are two schools of thought: a decentralised utilisation of natural gas in highly efficient boilers, in micro-combined heat and power (CHP) plants and as CNG to fuel vehicles; and centralised energy use (gas, oil and coal) in large power plants in combination with CO_2 capture and storage (CCS).

In the first option natural gas is distributed to the customer where it is used for heat, power or traction in the most efficient way. In this option CO_2 cannot be captured and stored.

The second option is less efficient with energy being used to generate electricity that then has to be transported to distant customers. However, it is possible to capture and to store CO_2.

How can IGU deal with these two totally different options?

In recent decades the increasing use of carbon fuels has had a significant environmental impact. Considering the potential impact of the fossil fuels that are still available, it is not the fact that they are going to run out, but the climate change issue that will be the most important reason to accelerate the use of sustainable energy.

In several European countries CO_2 emissions trading has already started as one of the instruments provided for in the Kyoto Protocol. More countries will follow. Depending on the future price of CO_2 credits, more efforts will be needed to reduce the CO_2 emissions.

If IGU wants to be recognised as an important player in the management of energy transition it has to play a pro-active role and cross borders. It must continue to promote natural gas as the bridging fuel towards sustainability using the decentralised option for highly efficient local heating, micro-CHP and CNG. In addition it also must explore the options for centralised CO_2 capture (pre-combustion and post-combustion) and storage.

CCS should be done in cooperation with the coal industry as the use of both coal and natural gas leads to CO_2 emissions. And although natural gas is the fuel of choice for electricity generation, we have to be realistic. There is an enormous quantity of coal around the world and in the foreseeable future new coal-fired power plants will be built. Cooperating with the coal industry on CCS would reduce R&D costs and allow a cross-fertilisation of ideas and insights. It would mean a great challenge for both industries, but humankind is in need of the most cost-effective ways to curb CO_2 emissions.

Cooperation in CCS with others also represents a big opportunity. The gas industry has the technology and know-how covering production, storage and transport of natural gas, which can be applied to the transport and storage of CO_2. Moreover, the gas industry controls the empty gas fields that can be used for storage of CO_2.

In conclusion, there are threats but most likely more opportunities for the gas industry. We should play a leading role in CCS in cooperation with the coal industry.

IGU Events and IGU-related Events 2005-2007

2005

May 18-19
Eurogas Spring Session
Vienna, Austria

May 23-25
IGU/ICT Global Congress
Busan, Korea

June 3-4
IGM 95th Session
Barcelona, Spain

September 26-30
WPC 2005
Johannesburg, South Africa

October
IGM 96th Session
Brussels, Belgium
(Exact date to be confirmed)

October 13-14
2nd International Exhibition Committee Meeting for WGC2006
Amsterdam, The Netherlands

October 17-20
IGU Council Meeting
Tianjin City, China

2006

March 9-11
IGU Executive Committee
Goa, India

June 5
IGU Council Meeting
Amsterdam, The Netherlands

June 5-9
23rd World Gas Conference
Amsterdam, The Netherlands

October 8-11
3rd World Forum on Energy Regulation
Washington DC, USA

2007

April 24-27
LNG-15
Barcelona, Spain

November 9-15
World Energy Congress (WEC 2007)
Rome, Italy

You can find links to many of the above events by visiting www.igu.org and clicking on "Events". Under "Energy-related Events" in the drop-down menu you can also find a link to the WEC Events Calendar displaying a multitude of energy-related events.

For the IGU Secretariat
Peter K. Storm: *Secretary General*
Lisbeth Koefoed: *Assistant to the Secretary General*
Lotta Hållén-Kragh: *Secretary and Webmaster*

For ISC
Editor-in-Chief: Mark Blacklock
Copy & Picture Editor: Elena Christodoulou
Publisher: Nigel Ruddin
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Special Projects Director: Barry J. Smith
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Art and Design Director: Michael Morey

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Information from Organisations Affiliated to IGU: IANGV (34), IGM (36).

On Track for the 23rd World Gas Conference: KVGN.

Progress Report: Pascal Rossignol/AP (50), Transports Metropolitans de Barcelona (56), Sonatrach (63).

The President's Wise Persons Group: CIEP (88), Tim Eggar (89 left), AOC (89 centre), CERA (89 right).

IGU and Greenhouse Gas Emissions: IGU (92), Statoil (93).

Acknowledgements

The Expanding World LNG Markets: BG Group (100), Sakhalin Energy (101), Technigaz (102), Hoegh LNG (103), Cheniere Energy Inc. (106), Saibu Gas Co. Ltd (107).

The 40th Anniversary of LNG Exports: National Gas Archive, National Grid Transco.

GTL Goes Mainstream: Bjørn Vidar Lerøen/Statoil (120), Shell (121 & 124), Syntroleum Corporation (122).

Qatar to be a World Leader in GTL Production: Sasol Chevron (126), Qatar Petroleum (127).

The Lessons of Ghislenghien: Stijn Defrene/AP (130), Fluxys (131).

R&D in the Gas Chain: C. Mayhew & R. Simmon NASA/GSFC NOAA/NGDC DMSP Digital Archive (135), NASA (136).

The Global ICT Congress Comes to Asia: Busan Metropolitan City.

Joining IGU as an Associate Member: Shell International Ltd Photographic Services.

Preserving the Gas Industry's Heritage: Danish Gas Museum.

Camisea Gas is Flowing

Camisea is the name of the largest gas project ever started in Peru, with proven reserves in place of about 9 TCF and some 600 million barrels of natural gas liquids.

The development of Camisea gas – 20 years after its discovery – is a key component of Peru's strategy in the energy field. Being a reliable, low-cost source of energy, Camisea will benefit electricity end-users and improve competitiveness of the Peruvian industry. It will also help to reduce the current deficit in the hydrocarbons trade balance by substituting imports of LPG and diesel and allowing exports of naphtha and LPG surpluses.

Development of Camisea and the adjacent Pagoreni gas fields also opens the possibility for an export LNG project. Benefits will be felt nation-wide, especially in Cusco, where the regional and local governments will receive substantial revenues under an income tax and royalty sharing scheme (canon).

The two structures that contain the Camisea reserves are located within a tropical rainforest, near two zones famous for biodiversity: Apurimac Reserve and Manu National Park, northwest of Cusco, ancient capital of the Incas.

Special considerations have been made in environmental impact studies and social management plans to recognise not just the diversities in terms of flora and fauna but also ethnically, which includes absolute respect for property and land possession, religion or beliefs, promotion of culture, etc.

Development challenges

The complexities of the project and the commitment of the upstream consortium to sustainable development led to a special "off-shore inland" design for the purpose of minimising potential socio-environmental impacts. Briefly, this comprises directional wells drilled from existing locations, gas processing facilities concentrated on a site previously occupied by settlers, no roads to be opened, no forced contact with isolated indigenous people and the adoption of international standards where these were more demanding than local ones.

Considering that access to the remote Camisea fields is only by aircraft or by river barges, and that the river is navigable only for a short three-to-four-month window each year, an enormous logistics and procurement coordination effort had to be developed. Today we are proud to highlight what has been accomplished so far:

- Acquisition of 760 square kilometres of 3D seismic data;
- Drilling six new wells, building flow-lines from wells to plant and vice-versa;
- Erection of cryogenic and compression plants near the permit area (capacity 440 million std. cubic feet/day) and a liquids fractionation plant on the coast (Pisco) with an off-shore berth and four sub-sea pipelines to load vessels;
- Establishment of excellent relationships with neighbouring communities, both in the jungle and on the coast;
- Commencement of exploitation before the end of first initial contract due-date (August 2004).

Natural gas is being consumed in Lima by six large industrial consumers and a 300MW power plant. However, most of the gas produced is being re-injected in San Martin 3 cluster.

Liquids fractionated at Pisco plant average 31,000 barrels per day. About 50% of this production is exported.

Pluspetrol (operator), Hunt Oil, SK, Tecpetrol and Sonatrach form the joint-venture that was awarded a 40-year licence contract for the exploitation of these reserves.

More flexible gas supply is heading your way

Wherever and however you manage your gas business, having the flexibility to source, transport and receive your supplies quickly gives you greater security, choice and control.

This is why BP is pioneering flexibility in liquefied natural gas (LNG). We participate in LNG projects which supply well over 30% of the world's LNG. With a growing LNG fleet, we were the first major company to order new ships not tied to long-term contracts or supply sources, and our flexible commercial arrangements mean we can move cargo around at short notice and help you respond to unexpected demand.

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