SIGTTO – 30 Years of Serving the Industry

By Andrew Murray

The Society of International Gas Tanker and Terminal Operators (SIGTTO) was formed in 1978 and incorporated in Bermuda in 1979. The Society's objective has always been to ensure technical integrity and operational security of the liquefied gas transport chain. Drawing on the experience of members, it has published guidance on best practices with the aim of achieving high safety standards throughout the liquefied gas industry. Under the Bye-Laws, the Society does not engage in commercial aspects of the industry, nor does it promote sectional interests. SIGTTO signed a protocol of cooperation with IGU and GIIGNL in 2008.

The following paragraphs cover some of the current activities to demonstrate how the Society still is guided by the original aims of its founder members.

SIGTTO has developed a "first pass" compatibility web-based tool to assist ship and terminal operators. The website can be found at www.lngwebinfo.org.

LNG information portal

It has long been understood that compatibility between ship and shore is an essential safety aspect of LNG operations. SIGTTO has developed, over a number of years, a "first pass" compatibility web-based tool to assist ship and terminal operators. This compares the dimensions of a particular ship against the limitations of terminals in order that interested parties can see at a glance whether the ship concerned is physically constrained in being able to visit a port. The website can be found at www.lngwebinfo.org and is available to all SIGTTO and GIIGNL members.

LNG vessel owners are invited to complete a web-based questionnaire of approximately 30 pages. The information will cover such matters as length, breadth, dwt, etc., but will also include such matters as mooring configuration, manifold configuration and emergency shutdown (ESD) connections.

Terminal operators are invited to complete a similar terminal-based questionnaire of approximately 50 pages.

Once both ship and terminal details have been entered into the site it is possible to perform a first pass compatibility study. Whether or not a particular carrier has previously visited a port is also noted.

The vessel compatibility check is only a first pass check. The terminal or vessel operator must complete a detailed review of all compatibility issues prior to port clearance. The necessary information to complete this detailed review is included on the site.

The responsibility for accuracy of the information remains with the owner/operator and SIGTTO appreciates that the usefulness of the site is totally dependent upon member companies completing the questionnaire to the best of their ability and, as such, reminders are sent out to members to review and update the information on a regular basis.

SIGTTO has published sets of guidelines for the LNG (ABOVE) and LPG (BELOW) shipping sectors.

● LPG shipping suggested competency standards

In 2006, SIGTTO published a set of standards for the LNG shipping industry, a move that was welcomed by both members and the LNG industry in general. The positive response received prompted the Society to investigate the need for a similar set of standards for the LPG shipping industry. Feedback from members showed that such a publication would make a positive contribution to maintaining the industry's excellent safety record.

SIGTTO publications are based on what is accepted to be "Industry Best Practice" and as such it was necessary to form a working group comprised of a broad knowledge base of industry expertise.

The final document adopted for publication by the SIGTTO Board in April 2008 comprises of a set of standards that are not, and can not be, considered mandatory. However they do represent the current best practice for operating standards for officers. The requirements were aligned as closely as possible to the certification levels

required by the International Maritime Organisation (IMO) and adhere to the management/operations principle.

The book is written in two distinct sections, a summary of tasks required and the underpinning knowledge required for carrying out those tasks.

Subsequent to publication of *LPG Shipping Suggested Competency Standards*, the LNG standards were revisited by the secretariat and although content was not changed, the format of the publication was altered to bring it into line with the LPG publication. *LNG Shipping Suggested Competency Standards* (Second Edition) was published in the latter half of 2008.

Future publications

SIGTTO is committed to ongoing safety within the liquefied gas shipping industry and is constantly working on revisions of older publications in addition to new publication titles. Some of the publications currently being reworked/newly written include:

- *Suggested Competency Standards for LNG Steam Engineers*
  It is recognised by the Society and its members that steam-powered LNG vessels are the only merchant vessels employing steam propulsion systems. Steam LNG vessels are still being built and will be trading for many more years, yet, clearly, the industry knowledge base is contracting. The members felt that, if steps were not taken by the Society to protect the knowledge base, nobody else would do it for them.
- *Liquefied Gas Sampling Procedures*
  Following an incident during a cargo sampling operation at a UK port, the UK Marine Accident Investigation Branch requested SIGTTO to review guidelines on liquefied gas sampling procedures. After an industry-wide search for available guidance from other sectors of the industry, a small focused group of LNG experts are working on updating the existing document with a final document due to be published in the final quarter of 2009.
- It has been brought to the Society's attention that conflicts between vessel charterers and vessel operating companies exist regarding LNG officer experience. The Society has formed a small working group whose aim is to produce a model experience matrix that will be acceptable to all sides of the industry.

IGC Code

The current version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) remains substantially as drafted some 30 years ago. Increasingly, the membership has expressed concerns that it no longer fully fitted the needs for modern ships and their technology. The IGC Code is "owned" by IMO and a submission was made to IMO to update the document. Uniquely for IMO, the Organisation agreed that the industry should take the lead on the revision work with a plan to return a completed document to IMO for its consideration.

SIGTTO has taken on the role of coordinating what is a truly industry-wide commitment. There are currently 10 Working Groups under the guidance of a Steering Group. In total about 130 people from 18 countries representing some 48 companies/industry bodies are engaged in the work. The target date for return of the revised document to IMO is 2010.

The foregoing paragraphs give a snapshot of how the Society continues to serve the liquefied gas industry after more than 30 years in existence.

Captain Andrew Murray is SIGTTO's Technical Advisor (www.sigtto.org).

HÖEGH LNG

OFFERING THE COMPLETE OFFSHORE LNG VALUE CHAIN

production and liquefaction

transportation

regasification

market access

FSRU

Snøhvit

Neptune

- A highly skilled organization with a wide range of competence gained through LNG operation since 1973
- Merging competence, innovation and technology development
- Currently operating a fleet of four LNG carriers and with two innovative Shuttle and Regasification Vessels (SRVs) on order
- A fully intergrated company with in-house fleet management

LNG Carrier Fleet Surges as Trade Stagnates

By Mike Corkhill

Twelve months ago the wind was set fair for LNG shipping. LNG carriers were being delivered at an unprecedented rate from a select number of the world's leading shipbuilders and a surging demand for gas promised a 10% per annum growth in global LNG trade levels through 2015 at least. That was before September 2008, when the perfect storm, combining a global credit crisis with sharp downturns in consumer confidence and industrial activity, unleashed its fury.

Today, the LNG industry, like most sectors of the world economy, is in a chastened state. LNG carriers continue to be completed in record numbers, according to the originally negotiated contract schedules. In addition, large tranches of new LNG production capacity are coming on stream, as construction projects embarked upon four and five years ago draw to a close. LNG production capacity worldwide is on track for a 30% increase in 2009. Unfortunately, the demand for the newly available LNG volumes and the ships to carry these cargoes is nothing like what had been forecast.

Demand for gas in many of the leading LNG import nations is currently down by as much as 10% year-on-year. Overnight, the LNG sector has been transformed from a sellers' to a buyers' market and as many as 50 ships in the LNG carrier fleet of 325 vessels are effectively surplus to current requirements.

Newbuilding frenzy

Shipyards delivered a record 53 new LNG carriers in 2008 and a further 49 are scheduled for completion this year. The world's three largest shipbuilders, all Korean – Hyundai Heavy

LNG carriers continue to be completed in record numbers – three Q-max ships and one Q-flex vessel lined up at the Samsung yard in anticipation of a simultaneous naming ceremony.

Industries (HHI), Daewoo Shipbuilding & Marine Engineering (DSME) and Samsung Heavy Industries (SHI) – are responsible for the construction of approximately 80% of these new ships. In recent years the three yards have refined, streamlined and increased their LNG carrier production capabilities to the extent that no other yards are able to construct such vessels as quickly, efficiently and competitively as this Korean triumvirate.

The capabilities of the Korean shipbuilders have helped to meet the LNG industry's burgeoning demand for new vessels over the past decade. The delivery by Samsung of *Tangguh Jaya*, a 155,000 m^3 membrane tank vessel, to K Line on December 29, 2008, marked the entry into service of the 300th vessel in the current world LNG carrier fleet.

A measure of the pace at which the LNG carrier fleet has expanded is given by the fact that it took 34 years, until 1998, for the in-service fleet of these ships to reach 100 vessels, and a further eight years, until April 2006, for it to break through the 200-vessel barrier. The 300-ship mark was reached, with *Tangguh Jaya*, just over two and one-half years later.

Newbuilding tailspin

However, because no new ships are being ordered, from 2010 onwards LNG carrier deliveries will tail off dramatically. The pace of new ship ordering had already dropped markedly before September 2008 due to the overheating world economy. With rising costs and a lack of skilled manpower and materials beginning to delay final investment decisions on new LNG liquefaction projects as far back as 2007, there has been no further requirement for new ships. The last order for conventional LNG carriers was in January 2008 when Shell Brunei Tankers contracted a pair of 148,000 m^3 ships at Daewoo.

Few participants in LNG shipping will feel the negative impact of the present boom and bust cycle as much as shipbuilders. Most of the 58

Two Sakhalin II trains are amongst the new LNG production units on stream this year. From left to right at the export terminal's inauguration ceremony are: HRH Prince Andrew, the Duke of York; Maria van der Hoeven, the Dutch Minister of Economic Affairs; Japanese Prime Minister Taro Aso; and Russian President Dmitry Medvedev.

LNG carriers remaining on order at presstime will have been completed by the end of 2010. In addition, the top LNG carrier builders are also leading constructors of container ships and tankers and the demand for these types of vessels has also evaporated.

Because no one expects the rebound in either economic activity or the demand for new ships to be particularly strong, when they do occur, the end result is that Hyundai, Daewoo and Samsung face a lean spell commencing in 2011 and stretching for two years at the very least. The need to absorb existing tonnage surplus to present requirements will further delay new orders.

As shipyards face up to the challenges of retaining their skill base and production capabilities during the coming period of severely restricted ship construction activity, it is becoming more and more likely that the number of LNG carriers

Mozah, the first Q-max ship to enter service, delivers an LNG cargo to the new South Hook terminal at Milford Haven, UK.

delivered in 2008 and 2009 will never be equalled.

Qatar's large gas carriers

While acknowledging the tough times which lie ahead, it is worth noting another recent major achievement by the LNG shipping community, i.e. the establishment of a 45-ship fleet of the largest LNG carriers ever built. When Qatargas and RasGas in Qatar decided earlier this decade to build, between them, six mega-trains, each capable of producing 7.8 mtpa of LNG, it was agreed that optimum economy of scale benefits could be achieved if the cargoes produced by these units were carried in large gas carriers with hull dimensions similar to those of very large crude oil carriers.

Qatar Petroleum and ExxonMobil, its lead partner in several of the Qatargas and RasGas mega-train projects, established a ship design team to study the options. It was decided that the transport needs of the new trains could best be met with the construction of a fleet comprising 31 Q-flex ships of approximately 216,000 m^3 and 14 Q-max ships of 265,000 m^3 in size and the ships were duly ordered at the Hyundai, Daewoo and Samsung yards.

Qatar Gas Transport Company, or Nakilat, part owns or fully owns all 45 vessels in this fleet. By mid-2009 and within the space of 20 months, the three yards had delivered 27 of the Q-flex ships and nine of the Q-maxes, all on time according to the originally specified completion dates. The remaining nine of these ships are due to be completed by June 2010.

The Q-flex and Q-max ships are unlike any other LNG vessels in service. Their slow speed diesel propulsion systems are unique to the current LNG carrier fleet as are their powerful reliquefaction systems which enable all cargo boil-off gas to be processed and returned to the tanks as LNG. Each ship is provided with a pair of diesel engines and a twin propeller and rudder arrangement. The resultant shallow-draught, wide beam design provides for a readily manoeuvrable ship with a hull of superior strength and a full measure of propulsion system redundancy.

Q-flexes and Q-maxes carry 40 and 70% more cargo, respectively, than "conventional size" LNG carriers of 155,000 m^3. Nakilat has invested $7.3 billion in the 25 Q-flex and Q-max vessels that it fully owns, while the total investment for the full 45-ship fleet is $12.5 billion.

The first of the six mega-trains – Qatargas 2 Train 1 – loaded its first LNG cargo in April 2009 after a few minor start-up problems were rectified. The bulk of this train's output is earmarked for the South Hook import terminal at Milford Haven in South Wales. South Hook was commissioned in March 2009 and forms part of the world's first fully integrated LNG supply chain with Qatar holding a controlling stake in it as well as in the production and shipping stages.

Redirecting Qatar LNG

When the six mega-train projects were originally conceived, it was envisaged that much of their output would be directed to customers in the UK and the US. The LNG market has altered since then, not least through the discovery of significant

new sources of domestic gas in the US. While the two countries will remain important destinations for mega-train cargoes, a significant share has become available to other interested customers.

A measure of the underlying strength of gas as the fossil fuel of choice for the future, despite the current recession, is given by the fact that a number of other countries have recently agreed gas purchase contracts for available cargoes from the export complex at Ras Laffan in Qatar. Several Chinese oil and gas companies, for example, have lined up purchases and are providing the many new import terminals being constructed in China with the ability to handle ships up to the 266,000 m^3 Q-max size.

Fleet oversupply

Shipowners with their LNG carriers fixed on long-term contracts are relatively insulated from the current period of fleet oversupply and depressed demand for LNG. In contrast, owners with unchartered vessels serving the spot market are faced with much fewer opportunities than were available 12 months ago and, in cases where employment can be found, much reduced rates.

Owners with idle vessels are reluctant to lay them up, especially if the ships are new. The first year after delivery is the shipyard guarantee period and the time to discover any ship and equipment faults that may arise. Also, having invested in LNG crew training programmes, shipowners with new ships are keen for crews to become familiar with shipboard systems and procedures. As a result, only a handful of LNG ships are currently in full lay-up.

One possible safety valve for LNG carrier owners is the scrapping of older LNG carriers. Traditionally, the LNG shipping community has been reluctant to countenance scrapping. Such vessels have long services lives, traditionally of 40 years and prolonged by life extension programmes. On the other hand, fleet overtonnaging has never been as great as it is today and propulsion systems and cargo-handling plant on older vessels are not as efficient as their counterparts on the new generation of ships. Today, there are approaching 40 LNG carriers of 30 years of age and over. Those not fixed to a particular trade must be considered as prime candidates for the breakers yards.

Opening up offshore

Committed LNG carrier shipbuilders, too, have a straw to clutch at when considering future opportunities, i.e. the construction of offshore vessels and structures. Floating production storage and offloading (FPSO) vessels, including LNG FPSOs, represent a sector with particular potential. LNG FPSOs are recognised as the cheapest, most cost-effective and most expedient way to develop stranded offshore gas fields previously considered too marginal or too remote. The flexibility inherent in such vessels enables them to be moved to a new offshore location when one particular resource is depleted.

The industry has been working for several years to utilise and combine the technological advances made in LNG liquefaction, shipping and oil FPSOs in the development of LNG FPSOs. LNG transfers at offshore locations present another challenge that has been the focus of considerable attention. The first of a number of LNG ship-to-ship (STS) transfers in open water was carried out in 2005 and the industry has built on this experience in the ongoing development of a range of loading arm and cryogenic hose options for offshore transfers.

Samsung already holds orders for four LNG FPSOs from Flex LNG. These so-called LNG producers will have a storage capacity of 170,000 m^3 for LNG and 50,000 m^3 for condensate. Their hulls will incorporate stainless steel tanks built to the self-supporting, prismatic shape, IMO type B (SPB) LNG containment system.

Daewoo is developing an LNG FPSO design in tandem with Hoegh LNG which is based on the GTT NO 96 containment system and features a

Flex LNG's first LNG producer vessel will introduce the floating LNG production era in a little over two years time.

double row of reinforced membrane tanks. For its part, Hyundai has recently commissioned its H Dock, the world's first FPSO-specific drydock, at its Ulsan yard. The facility is able to accommodate vessels of up to 1 million tonnes displacement.

Additional contracts for LNG FPSOs are believed to be imminent. Shell, SBM Offshore, Teekay and MISC, amongst others, have developed generic designs. Accommodating liquefaction plants on the relatively limited space available on an FPSO deck presents a particular challenge and all the shipowners promoting LNG FPSO projects have formed alliances with specialist engineering firms which will take responsibility for the units' topsides.

Offshore regasification underway

The drive for floating LNG production units is also making use of the industry's accumulating experience of offshore regasification. At presstime, the gas-handling systems onboard the world's second floating storage and regasification unit (FSRU) were being tested prior to the vessel's commissioning. Both FSRUs are converted LNG carriers owned and operated by Golar LNG and both have been taken on 10-year charters by Petrobras for operation at dedicated berths in Pecém port and the Guanabara Bay. Golar has two more LNG ships earmarked for FSRU conversions over the coming year.

A second type of LNG ship capable of regasifying cargo onboard is the LNG regasification vessel. Excelerate Energy, a US-based LNG importer and marketer, and the Belgian shipowner Exmar cooperate in the operation of a fleet of five Energy Bridge Regasification Vessels (EBRVs) with a further three due for delivery by June 2010.

The capabilities of the EBRVs are realised through the dockside GasPort and offshore Gateway terminal facilities in which Excelerate has

invested. On the Gateway front, the Northeast Gateway facility off the coast of Massachusetts entered into service in April 2009 as the eighth US LNG import terminal. Gateways make use of submerged turret loading buoys and subsea pipelines through which regasified LNG is pumped to the onshore grid. Northeast Gateway is the second such facility, Gulf Gateway in the US Gulf having handled its first cargo in 2005.

As regards GasPorts, the two-year old Teesside GasPort in the UK received its first full cargo of LNG earlier in 2009 while Argentina has recently signed up for two more years of GasPort deliveries at its Bahía Blanca facility. Bahía Blanca became the first port in South America to import LNG when operations started in May 2008. Elsewhere, Kuwait is poised to inaugurate a GasPort operation at the port of Al-Ahmadi, while Belgium and Pakistan are carrying out feasibility studies.

In a typical GasPort operation the EBRV remains berthed at a dedicated dockside facility and LNG is delivered to the vessel by means of conventional LNG carriers. This operation makes use of STS cargo transfers using special cryogenic hoses. The EBRV then regasifies the LNG at the required rate and discharges it directly into the local gas grid via a high-pressure offloading arm. Excelerate points out that it took less than six months to construct the Bahía Blanca GasPort and bring it into operation.

Back to the future

Although the world LNG carrier fleet expanded by 20% in numerical terms in 2008, to reach 300 ships, it only completed approximately 3300 loaded voyages and delivered some 170 million tonnes of LNG. This was marginally less than the number of cargoes carried in 2007.

In the current economic climate, despite the start-up of eight new LNG liquefaction trains in 2009, it is difficult to see much improvement in the total number of LNG carrier voyages this year. Nevertheless, the market for gas will rebound, as will the LNG industry, before long. Chinese imports, Europe's push to diversify its sources of gas and increasing environmental concerns will be key drivers in the LNG trade revival. A continuation of the present low international gas prices will also encourage increasing LNG shipments to the US where a number of large new receiving terminals have been brought on stream recently.

Shipbuilders will have a relatively long wait before shipowners return to them with significant numbers of orders for new LNG vessels. However, the construction of LNG FPSOs offers one strand of opportunity in the shorter term for the larger yards with suitable facilities. While the frenetic pace of the dash for gas in recent years is unlikely to be repeated, a steady expansion of the global LNG infrastructure is on the cards once the industry emerges from the current trough.

Mike Corkhill is the Editor of LNG World Shipping *and* LPG World Shipping*, two journals published by Riviera Maritime Media (www.rivieramm.com).*

Brazil's President Luiz Inácio Lula da Silva (RIGHT) visits the new LNG import terminal in Rio de Janeiro's Guanabara Bay with Petrobras CEO José Sergio Gabrielli de Azevedo (LEFT).

Non-stop LNG operations

by Kees den Bakker – Shell Global Solutions International B.V.

Introduction - If you think safety is expensive then think about the cost of an accident

Do you feel comfortable driving a car at over 200 km/h or hanging off a cliff? We all know that exceeding safety limits means danger. So why would you risk operating a liquefied natural gas (LNG) plant outside its design limits?

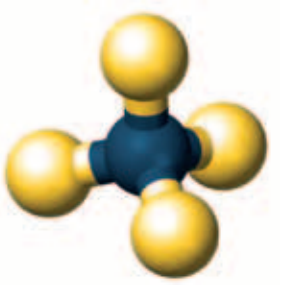
Why is operating within limits important? Over the last few decades, several serious industrial incidents have occurred including: the Texas City refinery explosion, the Piper Alpha fire, the Longford gas explosion, the Bhopal toxic gas leak, and the Flixborough chemical plant explosion. These incidents cost lives and caused major damage to installations and the environment. The investigations have shown that the causes of these incidents were very similar and were often related to operations outside the design limits (an abnormal situation).

Examples include the overriding of safeguarding functions, alarms not working and no handover between shifts. Why is it possible that these incidents could be repeated? The message here is clear: without a culture of learning in place, incidents can and do happen, irrespective of past experience.

LNG plants have hazards that can potentially lead to an incident when not managed well, for example:

- LNG plants operate a continuous process with no hold up vessels. Process upsets could result in flaring or, when not properly safeguarded, in gas releases into the atmosphere potentially resulting in an explosion.
- The operating environment is often corrosive (salt spray, high ambient temperatures). A particular hazard is corrosion under insulation, which is difficult to inspect. Such corrosion can cause leaks in a pipe or vessel that could release gas in to the atmosphere.
- Power generation is often in island mode (not connected to public power grid). Thunderstorms (lightning) or other upsets can cause a power black-out that may disturb LNG production for days.

To prevent incidents LNG asset owners require systems and processes that reduce the risks in their plant below acceptable levels.



Gas-GAME

Shell has developed a framework for Asset Integrity and Process Safety Management (AIPSM). It is called **Gas-GAME**, which stands for Global Asset Management Excellence for Gas sites. Gas-GAME covers the 11 topics that are considered to be vital for AIPSM:

Figure 1: The Gas-GAME modules

The program is rolled out globally across LNG/NGL plants both internally within Shell as well as across Shell-advised plants.

It used to be said that three things were important in LNG: ***reliability***, ***reliability*** and ***reliability***. Nowadays ***process safety*** should be added. A reliable plant is a safer plant and operates at lower cost.

Gas-GAME and the aircraft industry

There are many parallels between the LNG process and aircraft industry.

Aircraft		LNG Process
Plane	◀ ▶	Plant
Pilot	◀ ▶	Panel man
Autopilot	◀ ▶	Advanced Process Control
Emergency landing	◀ ▶	Plant trip shut down
Fly by wire	◀ ▶	Distributed control system
Flight simulator	◀ ▶	Dynamic process simulator
Cockpit	◀ ▶	Control room

The aircraft industry has an excellent safety record which is the result of putting in place the right framework of systems, procedures and behaviours. These include a safety management system, reliability management, standard ways of working such as procedures/checklists, training on abnormal situation management (ASM), learning from incidents, communication protocols and so on. Much of this can be applied to the gas processing industry and this is the aim in Gas-GAME.

Did you know that the best landings are made on autopilot? The best plant operations are carried out by automated procedures.

Cockpit Boeing

Control room LNG plant

Figure 2: Parallel between cockpit and control room

Gas-GAME builds on the following key elements:

- the requirements for process safety and asset integrity (the Standard);
- the work process (go with the flow); and
- key performance indicators (KPI) and audit protocol (you cannot control what you do not measure).

Critical to the success of Gas-GAME is program change management (PCM). The implementation of Gas-GAME means changes in behaviours and organisation. PCM drives the effort from design to implementation and sustains the result. It addresses:

- leadership alignment;
- communication; and
- stakeholder management.

PCM is all about getting Gas-GAME into the "hearts and minds" of people.

Gas-GAME - Real at Nigeria LNG

At Nigeria LNG, the implementation of the Gas-GAME programme is halfway through but a number of interesting results have already been achieved. Four mini case studies outline the progress.

Example 1: Ensure Safe Production (ESP)

"We know our limits and we operate within those limits all the time"

Nigeria LNG was experiencing a high number of operating alarms on its control system. Panel operators were consequently drowned in regular alarm floods, which sometimes made it difficult to recognise critical alarms and define a proper response.

To solve this, Nigeria LNG implemented the ESP module (one of the Gas-GAME modules) which can be seen in *Figure 3*:

Figure 3: The ESP module

Although implementation of the module is still under way, the results so far show:

- that the operating window is much better defined;
- a 40 to 90% alarm reduction in utilities area; and

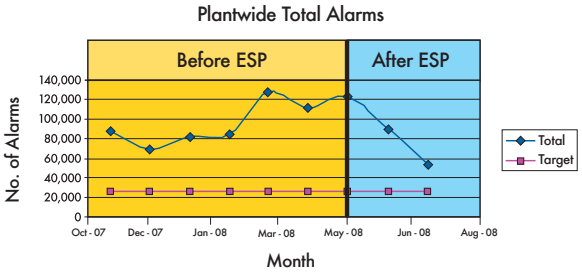


Figure 4: Alarm reduction after ESP introduction in May 2008.

- that communication during shift handover has been improved.

Example 2: Operator task management (OTTER®)

"Small tasks drive big results"

Figure 5: OTTER handheld device

At Nigeria LNG the outside operator is accompanied on his rounds by a 'friend'. This is OTTER (Operational and Technical Tasks for Efficient Rounds), a handheld device comparable to a PDA or palmtop. OTTER contains operational or maintenance tasks obtained from a reliability integrity system (e.g. Reliability Centred Maintenance) and it is used to navigate the operator from location to location.

At Nigeria LNG the use of OTTER has empowered the field operators. The results from using OTTER are:

- structured outside operator rounds;
- well defined operating limits and abnormal situation management;
- improved situational awareness of the outside plant condition;
- reduced downtimes;
- increased availability upon demand of standby equipment; and
- reliability improvements increased the mean time between maintenance.

The proactive monitoring strategy using OTTER provides a platform to improve Nigeria LNG's operations, environmental compliance and process safety.

Example 3 – Maintenance Execution

"doing the right job, at the right place and time, with the right tools and the right people"

Best-in-industry operations proactively plan over 95% of all their maintenance activities and have less than 5% of reactive maintenance (i.e. schedule breakers).

Properly prepared and scheduled work is three to four times less costly than unprepared work. Not having the correct parts, tools and skills in the right place at the right time can result in waste in the form of:

- delays, confusion and lost time;
- inadequate co-ordination of materials that results in false starts, delays or makeshift repairs;
- poor co-ordination of crafts/disciplines that means excessive waiting time and idle personnel;
- poor timing of equipment isolation and shutdown leading to excessive downtime; and
- poor quality of work which jeopardises future reliability.

The ME module provides the capability to move towards "best-in-industry" performance.

For example, at Nigeria LNG an "Efficiency Improvement Programme" has been introduced to support their implementation of the maintenance execution module. Benefits realised from the program include:

- production of a new (6th) LNG train started with the same manpower as for 5 LNG trains;
- better planning and scheduling to support the drive towards a more proactive culture; and
- improved discipline of people and productivity through the use of robust maintenance management control systems.

Conclusion

Incidents have happened and, unfortunately, may happen again. But they should not happen so it is time for change.

Building on its many years of operational experience and knowledge in gas, Shell has created Gas-GAME, a framework to improve Asset Integrity and Process Safety.

Gas-GAME is applied to Shell-advised gas facilities around the world. Nigeria LNG, a Shell-advised Company, is a front-runner with Gas-GAME and is already experiencing the benefits.

THE RIGHT ANSWERS

START WITH THE RIGHT QUESTIONS

IT'S A STATEMENT OF THE OBVIOUS, BUT IN OUR EXPERIENCE, IT'S ONE THAT OFTEN GETS OVERLOOKED — PARTICULARLY WHEN THE QUESTIONS BEING TACKLED MAY BE HIGHLY COMPLEX. OUR GETTING TO THE HEART OF SOMETHING COMES FROM BEING ABLE TO PUT TOGETHER AN INTEGRATED TEAM FROM DIFFERENT BACKGROUNDS — ONE THAT SPECIALISES IN ASKING THE RIGHT QUESTIONS. THIS PRETTY MUCH SUMS UP HOW WE WORK, BOTH AMONG OURSELVES AND WITH OUR CLIENTS.

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Life Cycle Assessment of the European Natural Gas Chain – A Eurogas-Marcogaz Study

By M. Papadopoulo, S. Kaddouh, E. Dridi-Dastrevigne, A. Cigni and D. Hec

Life cycle assessment (LCA) is a method aimed at assessing and accounting for the specific impacts of all the contributions from all the activities/processes needed for the production of a particular good or service in the whole chain ("from cradle to grave").

Initially, LCA was developed by and for industry in order to make strategic decisions concerning the environment and was broadly used in the 1990s to manage global environmental problems. According to the ISO 14040 and 14044 standards, LCA is a global environmental assessment method to evaluate the environmental burdens (global warming, resource depletion, etc.) associated with a product or activity over its life cycle. Considering the whole life cycle helps to ensure that no environmental burdens are shifted to other phases or among different impacts.

Until now, however, the European natural gas industry has not developed a detailed LCA. Only IGU has produced a worldwide LCA, which was presented at the 23rd World Gas Conference in 2006.

Aims

In a context of development of life cycle oriented regulations and the launching of the European Reference Life Cycle Data System (ELCD) project supporting business and policymaking in Europe with reference data and recommended methods on LCA, the Eurogas-Marcogaz Joint Group "Environment, Health & Safety" decided to set up a working group on this topic and to establish an LCA of the European natural gas chain in order to determine the environmental footprint of the whole natural gas chain, utilisation included.

The Eurogas-Marcogaz LCA covers all steps of the natural gas chain – a gas-fired combined cycle power plant under construction in Kårstø, Norway.

Scope of the study

The Eurogas-Marcogaz LCA covers all steps of the natural gas chain for the year 2004: from production to utilisation, including transport by pipelines and tankers, liquefaction, gasification and distribution of natural gas. Three different utilisations based on the best available technologies (BAT) are considered [reference 1]:

1. Electricity production with a natural gas combined cycle;
2. Heating with condensing boilers (domestic and commercial use);
3. Combined heat and power production (domestic and commercial use).

Substances and impacts considered

It was decided to focus on the main environmental impacts of the systems studied, for which Marcogaz can provide a real added value regarding the data quality [3]. The following substances have therefore been considered:

- Atmospheric emissions: greenhouse gases (CO_2, CH_4, CO, N_2O), acidifying emissions (NO_x, SO_x), particulate matters, non methane volatile organic compounds;
- Energetic consumptions: natural gas, oil, coal, uranium, hydropower.

The associated impacts used in Eurogas-Marcogaz LCA are the following:

- Global warming potential (GWP);
- Acidification potential (AP);
- Non-renewable energy demand.

Results and conclusions

A confirmation of the good performances of natural gas

The results of the Eurogas-Marcogaz LCA confirm the good performances of natural gas as a fuel (*see Figure 1*). One kWh of useful heat produced from natural gas with a best available technology generates about 230 grams of CO_2-equivalent on its whole life cycle; the kWh of electricity produced with a natural gas combined cycle emits 393 grams of CO_2-equivalent. Generally the results support the figures used in existing generic LCA databases [2] for global warming and non-renewable energy resources depletion although both impacts are slightly lower in this study.

A low contribution of the natural gas upstream chain to the total GWP of heat and electricity supply

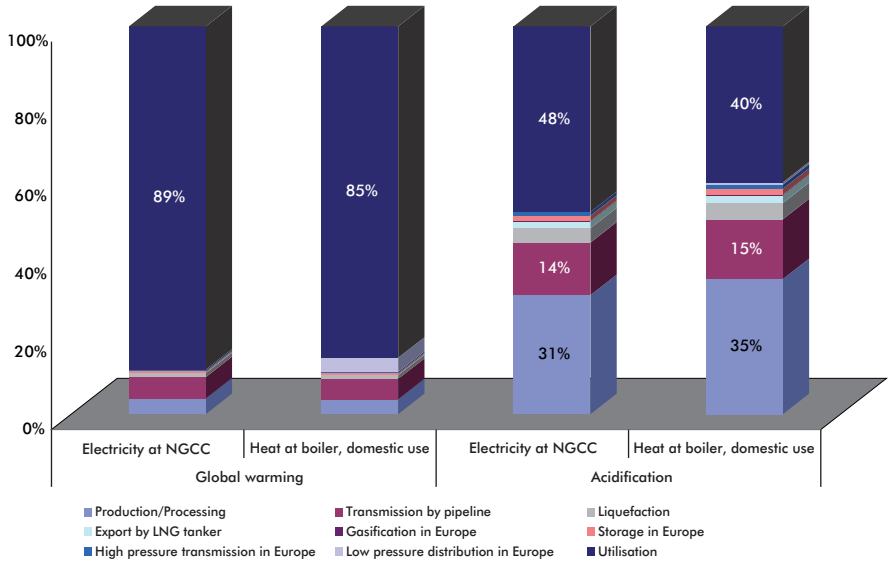
The utilisation phase (combustion at power plant or boiler) is predominant in terms of greenhouse gas emissions: its contribution exceeds 85% of the total GHG emissions. CO_2 is by far the main sub-

RESULTS OF THE EUROGAS-MARCOGAZ LCA

For 1kWh	*GWP (geq CO_2)*	*AP (mg eq SO_4)*	*Non renewable energy depletion (kWh)*
Heat at boiler – domestic use	236	129	1.12
Heat at boiler – services and buildings	224	120	1.09
Heat at CHP – domestic use	243	168	1.15
Heat at CHP – services and buildings	232	189	1.07
Electricity at CHP – domestic use	243	168	1.15
Electricity at CHP – services and buildings	228	186	1.06
Electricity at combined cycle plant	393	257	1.90

LEFT
Figure 1.

CONTRIBUTION OF EACH STEP TO GLOBAL WARMING AND ACIDIFICATION FOR ELECTRICITY PRODUCTION WITH A COMBINED (NGCC) CYCLE AND HEAT PRODUCTION WITH A DOMESTIC BOILER



ABOVE
Figure 2.

stance contributing to climate change, accounting for about 95% of the GHG emissions, while methane emissions account for the remaining 5%.

In terms of acidification, utilisation (40 to 53%), production/processing (27 to 35%) and international pipeline transmission (12 to 15%) are the main steps contributing to this impact. NO_X emissions occurring during natural gas combustion in power plants and boilers and in compressor drivers (for liquefaction and pipeline transmission) account for about 80% of the acidifying emissions, SO_X emissions representing the other 20%. Those are mainly emitted during production/sweetening of the sour natural gas produced in Russia and Germany, as well as during LNG transport through the use of heavy fuel oil as propulsion energy. (*See Figure 2.*)

A possibility to identify differences between the supply chains

This LCA also allows the assessment of the environmental performances of the different supply chains of natural gas arriving in Europe[1] (*see Figure 3*) as is illustrated in the following examples:

- The production of heat with a condensing boiler from natural gas coming to Europe as LNG emits about 27% more GHG than heat production with natural gas coming from European countries through conventional pipelines. This is mostly due to the high energetic consumption of existing liquefaction units and shows the strategic importance of investing in highly efficient liquefaction plant projects, such as the Snøhvit liquefaction plant in Norway, which should be two times less energy-consuming than existing liquefaction plants.
- Heat production from Russian natural gas emits about 20% more GHG than heat production with natural gas coming from European countries. This is mainly due to the distance covered from the Siberian fields to the EU-25 (about 5000 kilometres); in comparison, the distance covered from the European production fields is 1000 kilometres on average. The choice of a specific leakage rate on the Russian export pipeline systems has a low impact on the final results: a sensitivity analysis showed

1 European gas chains: mix of natural gas coming from Norway, Great Britain, Germany and The Netherlands to EU-25. LNG chains: mix of natural gas coming as LNG from Algeria, Qatar and Nigeria to EU-25. Russian chain: natural gas coming from Russia to EU-25.

that the use of the highest value found in the literature (0.43%/1000 kilometres against 0.18%/1000 kilometres for the baseline case [4]) resulted in an increase of barely 2% of the total GWP.

A need for more specific and up-to-date data

Important differences with existing generic LCA databases [2] have been noticed particularly for CH_4 and SO_X emissions, which are generally overestimated in the upstream chain.

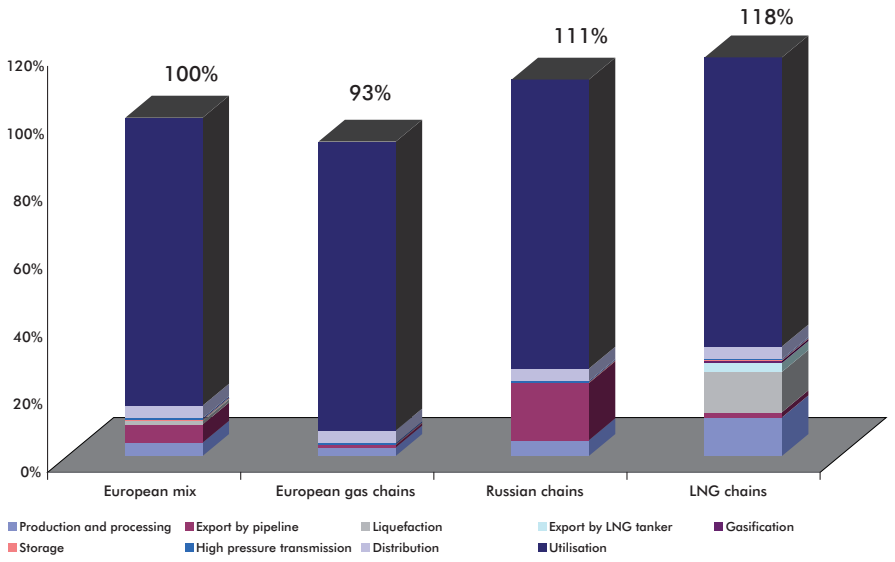
Indeed, methane emissions on the transmission and distribution grids are much higher in existing databases than the rates measured on the networks of different European companies (eight and two times higher on the transmission and respectively the distribution grids [3]). This results in a reduction by a third of total methane emissions associated with the domestic systems assessed in this study.

Moreover the ecoinvent model for the European natural gas supply was based on a sour gas share of 10.2%, representing the average European supply in 2000. However, in 2004, the estimated proportion of sour gas only reached 3.4%. This explains that the domestic systems assessed in this study emit less SO_X in their whole life cycle than the corresponding systems in the ecoinvent database.

These differences show the importance of not basing environmental decisions on generic databases without first assessing their relevance and applicability.

Marion Papadopoulo and Emilie Dridi-Dastrevigne are project managers and Salam Kaddouh is a research engineer at GDF SUEZ, while Alessandro Cigni is the Technical Adviser and Daniel Hec is the Secretary General of Marcogaz.

PRODUCTION OF HEAT WITH A DOMESTIC CONDENSING BOILER – REPARTITION OF THE GHG EMISSIONS AMONG THE DIFFERENT LIFE CYCLE STAGES



ABOVE
Figure 3.

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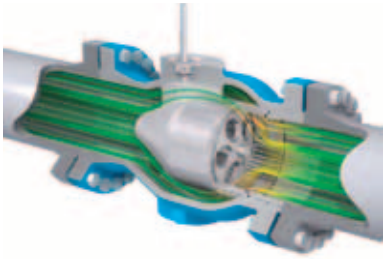
1 Paul Scherrer Institut. Life Cycle Assessment of New Natural Gas Conversion Systems in France (2007).
2 Ecoinvent v2 database.
3 Marcogaz internal data (2004).
4 Wuppertal Institut, Greenhouse Gas Emissions from the Russian Natural Gas Export Pipeline System (2005).

The Silent Success of Axial Excellence

Integrated valve systems for critical control and safety applications

Mokveld was founded in 1922 in Gouda in the Netherlands. In the mid-fifties the company started making valves, a development which accelerated when the Nederlandse Aardolie Maatschappij B.V. (joint venture between Shell and ExxonMobil) discovered the Groningen gas field in 1959. Mokveld started delivering valves for the production of the billions of cubic meters of gas and over the years was challenged to respond to constant changes with respect to safety, noise and emissions.

Now, 50 years later, the company has gained an excellent reputation as an international supplier of quality valve products. Not just a valve manufacturer, however, a niche player committed to contribute to safe, reliable and sustainable development of the world's energy resources. Two important products in this perspective are the High Integrity Pressure Protection System (HIPPS) and the axial control valve.

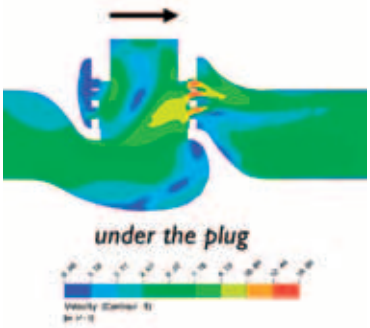


High Integrity Pressure Protection System (HIPPS)

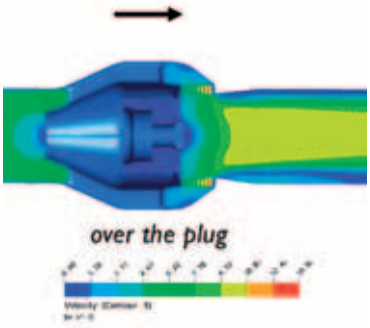
A HIPPS is a type of safety instrumented system designed to prevent over-pressurisation of a plant or pipeline. The HIPPS will shut-off the source of the high pressure before the design pressure of the system is exceeded, thus preventing loss of containment through rupture (explosion).

In conventional systems overpressure is dealt with through relief systems. Disadvantages are release of process fluids or their combustion products into the environment and a large footprint of the installation. Conventional relief systems are no longer acceptable and HIPPS provides a popular solution in cases where:

- high-pressures and/or flow rates are processed
- the environment is to be protected
- the economic viability of a development needs improvement
- the risk profile of the plant must be reduced



Conventional Globe Valve
Preferential flow deteriorates trim performance and leads to unbalanced trim forces.



Axial Control Valve
Axial flow and source treatment by Total Velocity Management is key to reliability

In the early 1970s Mokveld supplied the first HIPPS to (EON-) Ruhrgas for protection of the German Gas Grid. As market leader Mokveld has developed and promoted this technology for almost 40 years now. Final element in Mokveld HIPPS is the axial on-off valve and actuator with thoroughly documented reliability data

Axial Control Valve

Control valves are critical elements in a process loop. Malfunction or failure of a control valve can seriously affect safe plant operation and the environment. Selecting a valve with proven reliable performance will help to reduce costly maintenance and lost production time.

Conventional globe style control valves are still used extensively. However, the "S" shaped body results in preferential flow with localised high fluid velocities being the prime source of noise, erosion, vibration and malfunction resulting from unbalanced forces. Prevention is better than cure. Mokveld Total Velocity Management® concept is an intelligent axial valve design that carefully manages fluid velocity in all areas of the valve (trim and body). Source treatment by Total Velocity Management® is the key to reliability and safety.

In the axial flow design the streamlined annular flow path – and the evenly distributed flow through the cage – reduce high local velocities, turbulence and impacts of flow jets and particles. This is fundamental for reliable valve performance because vibration, erosion and unbalanced flow and forces are avoided. With a minimum of turbulence and change of the fluid velocity, there is no energy conversion in the valve body itself. Pressure drop is taken over the trim only, which has been specifically designed for this task. As a result unplanned process downtime is avoided and maintenance cost (total cost of ownership) are reduced.

For more information and brochures please visit us at the 24th World Gas Exhibition, stand A22 or refer to www.mokveld.com

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Research Collaboration – Meeting the Challenges Facing the Natural Gas Pipeline Industry

By George W. Tenley, Jr.

As IGU delegates left Amsterdam for home after the 23rd World Gas Conference in June 2006, the gas industry was, like most industries, riding the crest of rapidly expanding opportunities brought on by the new globalism in business and trade, the growing need to confront serious, systemic environmental threats, and a rapidly changing workforce and the means and mechanisms by which work would be performed. At the same time, the ability to fund new projects anywhere in the world was expanding apace. In short, the gas industry had entered one of the most energised phases in its history, and was positioned to rightfully take its place as the essential fuel that would enable the next generation of energy to develop, take hold and flourish.

Pipelines such as the West-East in China are the core component to delivering the value and impact of natural gas.

Three years later, the world is dramatically different. The challenges above, then seen as the stimuli of opportunity, are now being felt as a significant drag on the ability of the industry to achieve sustainability, let alone predominate, in the energy mix. In the face of these dramatically changed circumstances, it is increasingly clear that the industry must recommit to innovation in order to achieve significant progress while optimising its resources and increasing its efficiency and effectiveness.

Production and utilisation are the two terminal links of the natural gas value chain, and each will require new investment in innovation, the primary component of which is research.[1] However, as the safety razor was to the blade, the cell phone is to mobile communication services and the medical device is to life-saving drugs, so pipelines are the core component to delivering the value and impact of natural gas. The ability of the pipeline industry to play its vital role will depend heavily upon innovation through research. As the natural gas industry redefines and repositions itself in a rapidly evolving world – economically, environmentally and socially – the role and value of pipelines will be essential to the industry's success.

In 2006, PRCI, in conjunction with several US pipeline industry stakeholders and regulators published a report on "The Role of Energy Pipelines and Research in the United States". Although focused on the natural gas and the oil

1 As used here, research is comprised of two elements developed either independently or, more commonly, in concert: "knowledge", its generation, enhancement and application; and "technology", the development of new mechanisms, tools and equipment used in all aspects of the operation of the pipeline infrastructure.

and petroleum products pipeline industries (hence the term "energy pipelines") in the US, several of the unique characteristics described in the report apply to pipelines around the world. Key among those characteristics with the widest global relevance are the following:

- Pipelines are the safest mode of transportation, and offer the greatest opportunity to transport massive quantities of essential fuels over great distances in the most cost-effective and timely manner.
- Pipelines are capital-intensive, long-lived assets and complete replacement is rarely an option, so robust maintenance regimes are essential.
- Pipelines are generally buried, making evaluation of the line's condition by visual inspection difficult; thus, research by pipeline operators and their vendors has resulted in mechanisms to inspect the lines internally and to detect leaks.
- Pipeline failures, while rare, can have catastrophic consequences due to the hazardous commodities they carry and the threat they pose to life, health and the environment; thus, research has focused on understanding failure mechanisms and developing practices to prevent and mitigate failures.
- Transmission pipelines are generally made of steel, and therefore are susceptible to corrosion; thus, research has supported a wide and intensive programme for corrosion prevention and control.
- Pipelines operate in right-of-ways across property typically owned by others thus presenting pipeline security and protection challenges. Accordingly, pipeline research has focused on how to protect the assets outside of company-controlled facilities.
- Pipelines are designed and constructed with large margins of safety, and the industry is continually developing ways to set and measure operating parameters that were previously not measurable.
- Pipelines are thoroughly regulated to assure both economically-sound and safe operations; thus, a key research emphasis has been, and will continue to be, the development of sound technical bases for standards, regulations and best practices.

When the current global challenges are overlaid on these characteristics, a picture emerges of where the pipeline industry must focus its research resources. Increasingly, the natural gas pipeline industry will need to respond to the following needs:

- Optimising the costs of the new and replacement infrastructure, including –
  - New pipeline designs that better account for the actual operating parameters under which the pipe will operate.
  - Stronger, higher-grade, thinner-wall pipe and

Route markers for a gas pipeline in Italy – pipelines operate in right-of-ways across property typically owned by others.

the welding means and mechanisms to enable its widest use, particularly in harsh environments.
  - Construction and installation enhancements that enable faster and more cost-effective project completion consistent with safety and a smaller environmental footprint.
  - More efficient (e.g., flexible) and environmentally-sound engines and facilities that provide system flexibility while reducing emissions and fuel usage.
- Enabling the pipeline infrastructure to transport emerging non-traditional products in a safe and cost-effective manner, including ethanol, biofuels, CO_2 and hydrogen.
- Assuring the integrity and reliability of the existing infrastructure upon which new service will be built, including –
  - Effectively, including cost-effectively, identifying damage to pipelines and determining the best means to prevent or manage it.
  - Deploying the means to determine the status of the right-of-way to prevent intrusion and impact on the pipe.
  - Improving pipeline facilities to enable future expansions and enhancements to meet new system demands, opportunities and mandates.
- Assuring the industry can effectively discharge its responsibilities to operate in an environmentally sound manner, including –
  - Reducing greenhouse gas emissions.
  - Enabling the continuing service of older engines while more effectively monitoring and controlling emissions.
  - Assuring that products flow with the lowest practicable loss to the atmosphere.

One of the most significant collaborations in pipeline research is the one formed by EPRG, APIA and PRCI.

Given the wide diversity these characteristics, challenges and needs suggest – in location, age, operating parameters and products – the focus and outcomes of research must be equally diverse. To develop and achieve a diverse research agenda with the resources available, the pipeline industry depends heavily upon collaboration. This is true even for companies who have their own, relatively robust research programmes. In terms of international reach, breadth of participants and impact, one of the most significant collaborations in pipeline research is the one formed by the tripartite partnership of the European Pipeline Research Group (EPRG), Australian Pipeline Industry Association (APIA) and Pipeline Research Council International (PRCI), each of whom operates under its own collaborative, voluntary model. Together, the three organisations have 110 members operating on five continents, the majority of whom are pipeline operating companies. This pipeline membership is augmented by steel and pipe manufacturers, inspection tool and equipment manufacturers, engineering and construction firms and field service providers.

Beginning 34 years ago as a bilateral relationship between EPRG and PRCI, the partnership was formally expanded in 2005 to a trilateral arrangement with the addition of APIA, operating through its Research and Standards Committee. The cornerstone of the partnership is a biennial joint technical meeting on pipeline research, the 17th of which was held in Milan, Italy in May 2009.

Although well-established as a forum for the members to share recent and emerging research results, for the first time the Milan meeting set the course for direct research project interaction, funding and management via interactive workshops. The topics to be considered during the next biennium are:

- Assessing the role and impact of human factors in damage and damage prevention.
- The development of shock tube testing as a means for fracture control.
- Assessing and controlling the delayed fracture phenomenon in mechanical damage.
- The development of a comprehensive database on stress corrosion cracking (SCC) experience.
- Development of new means to reduce construction and installation costs. (Note: In this work, the tripartite partnership will be expanded to include the International Pipeline and Offshore Contractors Association – IPLOCA.)
- Development of standards on the assessment of corrosion on pipelines not suited for in-line inspection.
- Establishing the criteria for assessing, monitoring and controlling corrosion growth rates.
- Developing the criteria and practices for the integrity management of subsea pipelines.

The final component of the diverse collaborative research enterprise is comprised of the firms, institutions and universities whose laboratories, field facilities, researchers and technologists form an enormous asset base from which the pipeline industry can draw. Throughout the history of the tripartite organisations the membership has been served well by the research conducted by such organisations as Battelle, CSM, C-FER, TWI, DNV, EWI, ICF, Southwest Research Institute and the Universities of Ghent, Woolongong, Adelaide, Colorado State, Queens College and Kansas State. These represent only a fraction of the research capability available to the worldwide pipeline industry. However, in order to optimise these assets across such a diverse spectrum of need and opportunity, every form of leverage is necessary, and the key leveraging mechanism in pipeline research is collaboration.

When IGU's 2006-2009 Triennium comes to a close with the 24th WGC in Buenos Aires in October, the natural gas industry will be well on its way to understanding how it will need to meet the present challenges to assure it remains the world's best hope for what remains of the hydrocarbon future. That future will be characterised increasingly by government policies designed to reconcile the environmental challenges of climate change with the growing world demand for energy. This reconciliation will require a broad commitment to innovation across all of the natural gas value chain. Fortunately for the pipeline sector, research continues to be a key source of innovation because of the commitment to collaboration in all dimensions of the effort.

However, to sustain its remarkable success over the years, the research enterprise must continue to attract the industry's leading companies who will be called upon to commit their resources in the form of both funding and, as important, their technical and operating expertise. Without question, the ability of the industry to continue to sustain and grow its research collaboration, and for leading companies to play their essential role in it, will depend heavily upon how they confront the challenges of a rapidly changing workforce. Because collaborative research depends so heavily upon the technical and operating expertise that participating companies contribute to the effort, the declining knowledge base and the large infusion of junior engineers and technicians will mean the overall pool of participating companies must expand. For the 2009-2012 Triennium, this challenge may turn out to be the most significant one facing the pipeline industry.

George W. Tenley, Jr. is the President of Pipeline Research Council International, Inc. (www.prci.org).

Your Partner in Gas Research & Technology

Background

The approach to national resource base optimisation, to investment decision support and to regulatory policy-making by TNO, as a main advisor to the national gas sector, is to study and model the full gas value chain. This includes not only the geological and infrastructural conditions, but also the interactions between the various actors/competitors, state monopolists and regulatory authorities. Rather than making projections based on a limited scope of the relevant environment, it is believed that modeling the full system is a better approach for studying changes in part of the system. In addition, TNO provides many technical solutions around natural gas flows

Gas compositional considerations for exploration in a mature basin

Any new gas has to be accommodated in the total system. In The Netherlands, the gas compositions from the different gas fields producing into the national grid have to be carefully balanced. Therefore, the gas composition of exploration prospects, including their production streams, needs to be predicted to test their impact on the total system.

Underground Gas Storage: arbitrage vs. rental contracts

Understanding how a new UGS fits in the local or regional market and which opportunities and risks exist, can only be achieved using a holistic approach. Exploiting price differentials by arbitrage can be more beneficial than fixed rental contracts. Combinations of both strategies can also be considered.

Gas exchange development

Understanding how to stimulate the trade on the gas exchange, at the expense of the OTC market (Over The Counter) and/or long-term contracts, depends on the interactions in the total system. The reliability of the price information generated at a super-critical trade on the gas exchange may be beneficial to all and outweigh the additional transaction costs.

Third Party Access

The various TPA regimes influence the investments made by companies. Predicting the company behaviours and their impact on Security of Supply again requires a total-system approach. TNO is currently developing new methods to research questions such as described above. Prototype models, EXPLOSIM and ENETSIM, are operational and ready to simulate the complex gas market. The models can also serve as a communication platform for the various stakeholders.

Compression Facilities

TNO has a track record of 40 years in designing safe and reliable compressor installations. We carry out full dynamic optimisation studies, in order to minimise dynamic forcing on the installations caused by unsteady flow and to minimise the resulting vibrations on the piping structure. For existing installations, we carry out debottle-necking studies and root cause analysis in case of failures or accidents. TNO has extensive proprietary software tools for process dynamic simulation.

Ship to ship transfer of LNG

TNO is appointed to define the qualification program for their system and to execute a complete test program. To expand the LNG market and add flexibility to the supply chain floating liquefaction is being developed besides the conventional LNG transport vessels and dedicated regasification vessels. These new developments however require offshore transfer of LNG from ship to ship. Until recently it was not possible to reliably transfer LNG which is typically done at 3 bar pressure and a temperature of -162°C. Good design of flow systems is essential to prevent high maintenance cost, reduced safety, increased environmental pollution, excessive energy consumption and poor reliability. A qualification test program is developed based on the requirements of the guideline pr-EN1474-II, and will be released by the end of 2009.

Optimisation of Production and Transport Facilities

As a gas field is depleted and reservoir pressure is reduced, the production is severely limited due to liquid loading. Below a certain gas velocity, liquid is no longer transported to the wellhead and a column of liquid builds up. Various solutions have been developed to delay the onset of liquid loading. Modeling multiphase flows in production facilities is a key activity of TNO. Applications of integrated well and reservoir modeling are Operator Support Tool for stabilising gas or water coning in these complex wells; TNO assist in the development of smart well control schemes; Furthermore we are developing down hole instrumentation and control hardware.

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Promoting Decentralised Energy in China

By David M. Sweet and Ju Ning

Climate change policy finally seems to be reaching a tipping point toward action and agreement, notwithstanding the downturn in the global economy and rising unemployment. While climate change initiatives may have a negative impact on some fossil fuels, the outlook for natural gas demand is promising, especially when natural gas is used to generate power locally through distributed combined heat and power (CHP) technology. Doing so can more than double the efficiency of power generation and significantly reduce greenhouse gas (GHG) emissions. While there is much talk about developing "smart grid" technology, we already have the technology to make the grid smarter, more flexible and more reliable by decentralising the points of generation and bringing them closer to the point of use. The wider use of decentralised energy (DE) is a key solution for bringing about the cost-effective modernisation and development of the world's electricity systems.

China has now surpassed the United States as the world's largest emitter of CO_2. (ABOVE) downtown Shanghai and (OPPOSITE) a coal-fired power station in Panshan.

China has now surpassed the United States as the world's largest emitter of CO_2. Even with the global economic crisis, China's economy continues to grow at an astounding annualised rate of 8%, as the Chinese spending stimulus takes hold with great success. As more Chinese than ever look to purchase cars and air conditioners, the demands placed on the conventional power grid will also grow. Thus, there is a substantial opportunity to reduce global emissions by increasing the efficiency of power generation in China through local gas-fired power. While some of China's policies recognise the benefits of CHP, development of CHP and clean distributed generation in China continues to lag. There is a great opportunity to enhance the policy, economic and institutional environments to ensure that CHP provides a greater share of power and heat generation in China. Existing DE technologies can reduce delivered energy costs and decrease emissions of CO_2 as well as other harmful pollutants.

WADE and the Asia-Pacific Partnership

The Asia-Pacific Partnership on Clean Development and Climate (APP) is an innovative effort to accelerate the development and deployment of clean energy technologies, formed by seven Asia-Pacific countries – Australia, Canada, China, India, Japan, Republic of Korea and the United States. The APP partners have agreed to work together and with private sector partners to meet goals for energy security, national air pollution reduction and climate change in ways that promote sustainable economic growth and poverty reduction. The Partnership will focus on expanding investment and trade in cleaner energy technologies, goods and services in key market sectors.

The APP aims to accelerate the development and deployment of clean energy technologies

The APP employs a unique public-private partnership model that brings together industry stakeholders and government officials to achieve Partnership goals. The APP is an integral component of US efforts to combat climate change, promote energy security and foster international economic growth and cooperation. As part of the US Government's participation in the APP, the US Department of State recently announced funding for several projects in China. Through a rigorous competition the WADE Foundation was chosen as a recipient of APP funding with its proposal to accelerate distributed generation/CHP in China.

The Programme – Accelerate clean distributed generation and CHP applications in China

Clean distributed generation (DG) and waste heat to power has the potential to significantly reduce GHG emissions and promote greater cost and network efficiencies. The wide-scale deployment of clean distributed generation technologies increases the diversity of energy supply, and can improve energy security and reduce fuel supply risks, particularly in remote areas. These efficient distributed generation technologies, which are ideally suited to mid-sized and smaller-scale applications, can

also alleviate poverty by improving access to energy services, as well as produce job opportunities and improve air quality and public health.

Some people and organisations in China already recognise the benefits of CHP. Many of the country's policymakers, utilities, engineers and energy users, among others, possess the expertise and skills needed to meet the challenge of increasing energy efficiency through CHP. There is a great opportunity to enhance the policy, economic and institutional environments to ensure that CHP provides a greater share of power, heating and cooling supply in China. This project will provide these stakeholders with the necessary information, tools and experience to enhance the effectiveness of their efforts to promote CHP and other forms of clean distributed generation.

The WADE Foundation's China Clean DG and CHP Programme will identify energy supply, industrial and institutional power and thermal load potential and assess the impact of CHP and clean DG at the provincial level, including the provinces of Shanghai, Jiangsu, Liaoning, Shandong and Sichuan. The WADE Economic Model will be used to quantify the economic and environmental benefits. The Programme will also identify the policy and economic barriers to optimal deployment. Workshops will be held at the provincial level to present these results and exchange ideas to accelerate DG/CHP at the local level. The full range of activities is described below.

Programme activities:

- Develop a detailed understanding of the potential for CHP and DG in Shanghai, Jiangsu, Liaoning, Shandong and Sichuan, including an analysis of the local fuel resources and supply outlook, and an estimate of potential energy and CO_2 savings benefits attributable to CHP and clean DG.
- Analyse and quantify the CHP opportunity using the proprietary WADE Economic Model.
- Work with the National Development and Reform Commission (NDRC) and national associations to develop a more complete understanding of current national policies and incentives for CHP and clean DG, and explore additional steps that could be taken to encourage further development.
- Work with key stakeholders to further understand the market and regulatory environment for CHP and clean DG development to develop clear recommendations and action plans specific to each province, and to cultivate high-level provincial champions who will take ownership of and help implement the provincial CHP strategy.
- Produce a handbook of best practices for successful CHP/DG development tailored to each target area that will assess barriers, review critical regulation and policy options and include best practices for the deployment of CHP and clean DG technology.
- Hold five regional workshops to highlight the potential opportunity for CHP and clean DG, initiate action plans and help promote strategic partnerships between US and Chinese companies.
- Organise a visit by key Chinese companies and officials to the US to see specific equipment in the field, and hold discussions with both CHP practitioners and policymakers.

China represents perhaps the single greatest opportunity for WADE to make an impact on the market for decentralised energy and the environment. Working with public and private partners through the APP project, WADE looks forward to this exciting challenge.

David M. Sweet is the Executive Director of the World Alliance for Decentralised Energy and Ju Ning is WADE's Country General Manager, China.

THE WORLD ALLIANCE FOR DECENTRALISED ENERGY (WADE)

WADE (www.localpower.org) is the world's leading non-profit organisation focused on distributed generation technology, policy and investment issues.

WADE works to accelerate the worldwide development of high efficiency cogeneration, onsite power and decentralised renewable energy systems that deliver substantial economic and environmental benefits. In an effort to raise the profile of cogeneration as a climate change mitigation strategy in the 1997 UNFCCC climate change negotiations, the International Cogeneration Alliance was founded. In 2002, the group changed its name to WADE and broadened its scope to include all manner of DE technologies.

WADE's five key objectives and programmes are to:

- Provide its Members and supporters with value added market intelligence, information and business opportunities;
- Bring about effective power sector reform which eliminates barriers to DE and creates real market opportunity for DE;
- Coordinate the creation and monetisation of high quality carbon credits from DE projects;
- Compile global data on all aspects of DE development; and
- Support the establishment of DE groups in every country.

WADE China Mission

The Mission of WADE China is to accelerate the development of decentralised renewable energy, high efficiency cogeneration and onsite power systems that deliver substantial economic and environmental benefits to China. WADE China can accomplish this through targeted advocacy, outreach and research

- Advocacy of policies designed to advance DE;
- Outreach through conferences, workshops and communications; and
- Economic and policy research, including quantification of the benefits of DE through use of the WADE Model.

For further information about WADE and WADE's activities in China, please contact:

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