

Gastech

The Official Show Daily Exhibition & Conference Newspaper



SAFETY | SERVICE | SOLUTIONS

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World Oil

DAY ONE
Tuesday, 4 April 2017

Gastech arrives in Japan, the founding father of the LNG industry

GAVIN SUTCLIFFE, Head of Content and Lead on Gastech's Governing Body, UK



Welcome to Tokyo, a vividly exciting and illuminated metropolis, and the capital city of the world's largest consumer of LNG: Japan.

Gastech arrives in Japan for the very first time, and we are particularly delighted that 10 major energy stakeholders have decided to cooperate as the event's Host Consortium. These 10 companies represent the full natural gas and LNG value chains, and are involved in diverse sectors such as upstream investment, project development, shipbuilding, LNG trading, technology, power generation and much more. Our Host Consortium of companies have thrown their enthusiastic support and expertise behind Gastech 2017 to make the event the largest in the industry calendar.

The event will uniquely draw together the global technical and commercial sectors, connecting those that are funding, commissioning and advising on projects with the engineers and technology experts delivering on the ground. We have gone through tough times for the past two years, so it has never been more important for the industry to connect and engage to drive down costs, increase efficiencies and, ultimately, win new business in globally significant markets.

We have seen major changes to the event, as well. The technical conference program has been considerably expanded and now provides more than four times as much content as previous events. Core themes for 2017 will expand into all aspects of the gas and LNG value chain, with

themes including: LNG shipping and shipbuilding; innovative technology; floating LNG; engineering, procurement and construction; gas and shale exploration and production; smart grids and fuel cell technologies; gas-fired power generation; digital and data management; and much more.

Core commercial themes will include candid and bold examinations of key subjects:

- The future for gas in a new world of tighter economics and environmental demands
- The evolution of pricing and trading in the gas and LNG markets
- The newest, and next, international frontiers for gas and LNG investment.

Our Global Meetings Service is a simple but smart way to arrange meetings with the visitors and delegates you have come to see at Gastech. Download the app for your smartphone, review who is attending and then book times to meet with them. This service was launched at Gastech 2015 and helped engage more than 1,000 people in valuable business meetings throughout the event. Make sure you try it out yourself and interact with the people you want to connect with during the week.

Numerous other superb new features have been added to both the conference and exhibition, so please be sure to review the guide and show materials to maximize your time and efforts while you are here.

On behalf of the event organizers and our Host Consortium, we wish you a productive and enjoyable week. ■

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With so much to offer visitors, Tokyo welcomes Gastech 2017 with open arms.



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Addressing the cybersecurity challenge: Making a holistic strategy a reality

LEO SIMONOVICH, Siemens

An emerging, but perhaps less well-known, danger is having a great impact on productivity, uptime, efficiency and safety. While cyberattacks on LNG equipment have not been widely publicized, some small breaches have occurred. In 2012, RasGas's website and email servers were attacked, although the company's production capabilities were not affected. Attacks on the operational technology (OT) side are growing and now comprise 30% of all cyberattacks.

The growing threat. Oil and gas companies are becoming increasingly digitalized, deploying a growing number of industrial control systems in networks along the entire value chain (FIG. 1). These companies recognize that connecting their industrial control systems to their enterprise IT networks improves operational transparency, business insights, operational efficiency, visibility and safety. However, the risks now associated with digitalization are exacerbated by aging infrastructures and legacy systems that were not designed with digital security in mind.

LNG and oil and gas companies must address this increasing connectedness and the accompanying greater vulnerability to cyberattacks. Developing a holistic strategy is the best solution, beginning with an explicit leadership commitment that is attached to real resources, and a focus to integrate cyber vigilance at all levels, develop

an industrial cybersecurity strategy, establish a cyber governance model, re-examine their security fundamentals and build smart infrastructure defenses that include extensive training.

Siemens is playing a crucial role in hardening products and helping operators shield their assets against cyber threats. The company offers a comprehensive digital portfolio and an approach that encompasses risk assessment, infrastructure security and the development of secure data management solutions. Siemens has hardened its own infrastructure and offers this expertise to its customers.

The "Web of Systems" security concept offers oil and gas customers integrated, "defense-in-depth" protection that encompasses plant, network and system security. The IIoT bridges digitalization and automation, allowing secure data processing and automation anywhere on the Web. Most automation suppliers rely on partners and third parties for industrial network components. Siemens' solution is designed to meet the environmental, availability and security requirements of tankers, pipelines, subsea and offshore production platforms, and onshore production rigs.

The Siemens portfolio addresses the most pressing issues, including endpoint security, securing data management, vendor risk and network visibility. Siemens offers advisory, design, technology and support services, connecting software, systems, simulation

and services to streamline engineering processes, manage information across lifecycles, model and analyze operational systems, and support condition-based maintenance.

The threat is too serious to wait until a cyberattack damages a company's

business and reputation. A technological focus is not enough: a holistic strategy requires the right kind of organizational structures and capabilities to support timely detection and agile response.

Meet Siemens experts by visiting the company's exhibit, 17-130 in Hall 2. ■



FIG. 1. LNG and oil and gas companies must address an increasing connectedness and the accompanying greater vulnerability to cyberattacks.

Gastech

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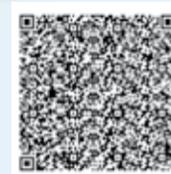
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Conference Program—Tuesday, 4 April 2017

PLENARY SESSION

08:45–08:55	Organizer's Welcome ■ Christopher Hudson , President—Energy, dmg::events global energy	
08:55–09:10	Japanese Government Welcome Address ■ H.E. Hiroshige Seko , Minister, The Ministry of Economy, Trade & Industry (METI) (pending)	
09:10–9:20	NOC & Ministerial Address ■ H.E. Dr. Sultan Ahmed Al Jaber , UAE Minister of State and ADNOC Group CEO	14:00–15:30
09:20–9:25	Official Opening Ceremony & Ribbon Cutting ■ Welcome our Host Consortium Members & Chairman	
09:30–10:00	Japanese Host Welcome & Preview of Gastech 2017: Gastech's host Chairman will lead a review with four senior Japanese energy executives, to listen to what they hope to see discussed during the Gastech event, and what topics are most anticipated. ■ Nobuo Tanaka , Chairman of the Gastech Japan 2017 Consortium, former Executive Director of the International Energy Agency ■ Yuji Kakimi , President, JERA ■ Takashi Anamizu , Senior Executive Officer, Tokyo Gas Co. Ltd. ■ Hajime Hirano , Executive Vice President, Group CEO, Energy Business Group, Mitsubishi Corporation ■ Hirotsu Fujiwara , Managing Officer, Chief Operating Officer, Mitsui & Co.	14:00–15:30
10:00–10:25	Global LNG Leader's Address ■ Maarten Wetselaar , Integrated Gas & New Energies Director, Shell	
10:30–10:40	Global NOC Address ■ Alexey Miller , Deputy Chairman of the Board of Directors, Chairman of the Management Committee, Gazprom	15:30–16:00
10:40–11:10	Networking Break	16:00–17:30
11:10–12:25	International Energy Leadership Panel Debate: "How are gas suppliers adapting to the changing global market?" ■ (Moderator) Simon Flowers , Chairman & Chief Analyst, Wood Mackenzie ■ Michael K. Wirth , Vice Chairman, Chevron ■ Robert S. Franklin , President, ExxonMobil Gas & Power Marketing Company ■ Khalid bin Khalifa Al-Thani , Chief Executive Officer, Qatargas ■ Patrick Pouyanné , Chairman & Chief Executive Officer, Total SA ■ Ryan M. Lance , Chairman & Chief Executive Officer, ConocoPhillips ■ Peter Coleman , Chief Executive Officer and Managing Director, Woodside Energy Ltd.	16:00–17:30
12:30–12:45	Investing in LNG's future—Address ■ Charif Souki , Chairman, Tellurian	
12:45–14:00	Delegate Networking Lunch	16:00–17:30
14:00–Close	Organized Business Meetings, Networking and Exhibition	

TECHNICAL SESSIONS

14:00–15:30	Stream 1: LPG/Ethane/Hydrogen Shipping 1. New Terminals, New Opportunities: But How Can We Avoid The Same Old Problems? ■ Bill Wayne , Principal Consultant, Seawallis Consulting
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- | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2. Risk Assessment of Liquefied Hydrogen Gas Carriers
■ Koichi Nishifuji , Manager of Natural Resources and Energy Department, ClassNK |
| 3. Introduction to a Liquefied Hydrogen Carrier for a Pilot Chain Project in Japan
■ Yukichi Takaoka , Senior Manager, Engineering Division, Ship & Offshore Structure Company, Kawasaki Heavy Industries Ltd. |
| 4. The World's First Ever Very Large Ethane Gas Carrier (VLEC)
■ Adnan Ezzarhouni , General Manager, GTT China |

Stream 2: Unconventional Gas to Supply LNG Projects

- | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. The Eagle Ford Shale Case Study: Improving Fracturing Efficiency by Understanding the Proppant Placement Mechanism in a Natural Fracture System
■ Tetsuya Tamagawa , Senior Manager, JAPEx Research Center |
| 2. Offshore Eastern Algeria Case Study: 3D Petroleum System Modelling and Hydrocarbon Occurrence
■ Mohamed Arab , Senior Geologist, Sonatrach |
| 3. Go East, Young Man - An Alternative for Western Canada's Potentially Stranded Gas
■ John Baguley , Chief Technical Officer, LNG Limited |

Stream 3: Carbon Reduction, Capture & Storage

- | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Tomakomai CCS Demonstration Project of Japan, with CO ₂ Injection in Progress
■ Yutaka Tanaka , General Manager of Technical and Planning Dept., Japan CCS Co. Ltd. (JCCS) |
| 2. Three-Dimensional Reactive Transport Simulation of the CCS Demonstration Project in Tomakomai
■ Kohei Akaku , Specialist (Geochemistry), Japan Petroleum Exploration Co. Ltd. (JAPEx) |
| 3. Environmental Benefits of Natural Gas: Enhancing Efficiency and Reducing the Carbon Footprint of Gas Networks
■ Maria Sicilia Salvadores , Director of Strategy, ENAGAS |

Networking Break

Stream 1: Gas Transmission and Pipeline

- | |
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| 1. FLNG to Subsea—Are You Following Me?
■ Andy Loose , Technical Director FLNG and LNG, KBR |
| 2. Subsea System Architecture for Coral South FLNG
■ Francesco Rossi , Project Engineering Manager, ENI Mozambique Engineering |

Stream 2: Digital and Data Management

- | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Change Demands Innovation: Embracing Cognitive Computing to Unlock Collective Intelligence—Both Past and Present
■ Brian Haggerty , Vice President Innovation Capability |
| 2. Supporting the Operational Efficiency of LNG Carriers with Big Data and the "IoT" (Internet of Things)
■ Deok-Hoon Jang , Manager in Business Development, NAPA |
| 3. Realizing the Full Value of Industrial Internet and Data Analytics in LNG Facilities
■ Jaleel Valappil , Principal Engineer/Group Supervisor, Bechtel Oil, Gas and Chemicals |

Stream 3: Gas to Liquids/Natural Gas Liquids

- | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Unlocking Value Through GTL Innovation
■ Shelley Wheeler , Gas to Liquids Business Development Manager, Shell |
| 2. FT-GTL Unlocks Value from Natural Gas
■ Michael Goff , Technology Manager, Black & Veatch |
| 3. Roll Out of Smaller Scale GTL Technology at ENVIA Energy's GTL Plant in Oklahoma City, USA
■ Neville Hargreaves , Business Development Director, Velocys |

People problems: Addressing operator competency

MARTIN ROSS, Honeywell Process Solutions

The first step in solving any problem is admitting that you have one. People are the process industry's greatest asset, but they can also be the weakest link without the support they need. Problems with operator competency impact process performance and can pose serious safety consequences. Weaknesses can only be addressed if they are first identified.

Fortunately, both leading and lagging indicators can reveal operator competency challenges before more serious consequences occur.

Look in, look out. The most obvious leading indicators are operator performance and knowledge, which are best assessed through a review. Can operators explain the process, the important process variables and how they are controlled? What are typical disturbances and standard procedures? Are they consistently completing tasks, making good use of the control systems and effectively managing upset conditions?

The work environment is a less direct measure, but can provide a powerful indicator of problems (FIG. 1). Symptoms of high stress or low morale among operators, or high staff turnover and absenteeism, can be indicative of concerns over competency. If operators are not confident that they are able to run the plant well, the chances are that they will not.

However, it is not enough just to listen to operators. Listen to what others

are saying: Are safety and environmental authorities giving poor reviews and identifying operator performance? Are underwriters' concerns about increased upsets or environmental emissions pushing up premiums? Is customer satisfaction suffering due to difficulties meeting schedules, or quality and specification requirements?

Listen to what the data is saying, as well. Trends in production performance can reveal competency problems: rising operating costs due to lower yields; higher energy and chemicals costs or falling catalyst activity; increased re-runs of off-spec products; and rising numbers of incidents. Competency may not be the root cause in each case, but it often is a contributing factor.

Take action. Any operator competency gap must be closed, and this requires a framework for evaluation and intervention. This framework is best based on continuous performance evaluation, both for new hires after training to identify weaknesses in specific competencies, and after an operator is "certified." Continuous monitoring identifies any drift from expected performance.

Deviations from expected norms must be identified, mapped to a competency gap, closed by refresher training, and continuously monitored to prevent future issues. Therefore, an ability to identify specific competency gaps and suggest training is essential.

One method is to examine an operator's roles and responsibilities and

identify the required competencies and proficiencies. For console and field operators, for example, a key responsibility is to operate under normal conditions. This, in turn, requires a set of competencies: operating unit controls, interacting with other units and executing a shift handover. These are linked to behaviors: explaining unit control schemes, manipulating controls with-

out adversely affecting the unit, troubleshooting control loops, and so on.

Finally, each competency can be assigned a proficiency level, from "aware" to "knowledgeable," "skilled" and "master." In this way, the competency model not only identifies gaps, but also specifies the training needed to close them and meet the needs of both the staff and the business. ■



FIG. 1. One method to increase operator competency is to examine the operator's roles and responsibilities and identify the required competencies and proficiencies.

LNG BUYERS COOPERATE TO PUSH FOR FLEXIBLE CONTRACTS

The world's largest LNG buyers are joining forces to secure more flexible supply contracts in a move that further shifts power from producers to buyers. Buyers seek supply flexibility concessions, such as the right to re-sell imports to third parties, which is not permitted under so-called destination restrictions.

Korea Gas Corp. (KOGAS) has signed a memorandum of understanding (MoU) with Japan's JERA, a JV between Chubu Electric Power and Tokyo Electric Power, and China National Offshore Oil Corp. (CNOOC) to exchange information and "cooperate in the joint procurement of LNG." Japan, China and South Korea account for approximately 55% of global purchases, according to energy consultancy Wood Mackenzie.

The unusual three-buyer alliance will pressure exporters like Qatar, Australia and Malaysia, which prefer to lock clients into decades-long supply contracts that oblige buyers to take fixed amounts of monthly volumes regardless of demand, with no right to re-sell unneeded supplies to other end users.

The LNG market is experiencing significant changes as the biggest ever flood of new supplies is hitting the market, mainly from Australia and the US. New production has resulted in a global installed capacity exceeding 300 MMtpy, while only 268 MMtpy of LNG were traded in 2016, according to Thomson Reuters data in Eikon. This has helped pull down Asian spot LNG prices by more than 70% from their 2014 peaks to \$5.65 per MMBtu. It has also increased the choice of suppliers, putting pressure on major producers like Royal Dutch Shell, Chevron, ExxonMobil and Woodside Petroleum to grant more flexible contract terms. Source: Reuters. ■

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Best practices in gas pipeline integrity

LARS LARSSON, Schneider Electric

As global oil and gas exploration continues, and more hydrocarbon sources are discovered and developed, the demand for pipelines increases. Pipeline operators are under severe financial and social pressures to avoid incidents that potentially cause crude oil and natural gas leaks. With regulators scrutinizing pipeline projects, the entire industry's reputation is at risk, and pipeline integrity must remain a focus of discussion.

"Pipeline integrity" refers to a comprehensive program that works to ensure that hazardous resources are not released from a pipeline while minimizing the impact in the event a release does occur. Although prevention methods may be considered as a one-size-fits-all solution, pipeline integrity encompasses a much broader definition and comprises three phases:

- **Prevention** activities and solutions seek to avoid gas leaks from occurring in the first place through proper design, construction, operation, maintenance, training and education.
- **Detection** activities and solutions help pipeline operators quickly identify if and when a leak occurs.

- **Mitigation** activities and solutions minimize the extent or impact of the leak and the resulting damage.

Because leak prevention is paramount, the three-phase process is understandable. As with most catastrophes, the best defense is a proactive offense. The technology and tools needed to anticipate potential threats to pipelines and identify anomalies are available today. The expression, "an ounce of prevention is worth a pound of cure," holds true for pipeline integrity—the costs of preventing a leak are inevitably much lower than the costs of cleanup, fines and potential civil liabilities, as well as damage to a company's reputation.

The process and planning that goes into the prevention of gas leaks is a multi-tiered strategy that can be split into three categories:

- Design and construction
- Operation and maintenance
- Training and education.

Design and construction. No two pipeline routes are the same, so gas leak prevention begins with specifying the technical requirements for each route. Advances in construction practices, such as more sophisticated testing, and

increasingly protective technology further safeguard pipeline vulnerability.

While it may seem like common sense to avoid areas that are susceptible to natural disasters and other geo-hazards, history has proven that one small mistake or lack of consideration of this detail play a large part in events that can lead to pipeline explosions. The geography of the terrain surrounding the pipeline must be evaluated, whether by topographical and geological maps, satellite imagery, aerial photography and surveys available in the public domain; all are suitable methods (FIG. 1). Natural disasters like landslides and earthquakes, soft soils such as swamps and bogs, and underground cavities like coal mines and caves should also be considered.

It is also crucial to implement correctly sized equipment. A steady-state pipeline simulation tool can validate the specified size of a pump or compressor through a computational model of the pipeline's operating conditions. This simulation can also ensure that it is hydraulically feasible for the pipeline to cross the terrain as designed. Surge suppression equipment must also be sized correctly. A transient pipeline simulation tool can model pipeline hydraulics to determine the design criteria for surge suppression equipment. Surge effects such as water hammer can severely damage a pipeline, causing hundreds of thousands of dollars in repair.

Operation and maintenance.

Beyond equipment construction, a major component of pipeline integrity is implementing a proper operations and maintenance schedule. When a pipeline is in service, continuously monitoring the operational and structural conditions within the pipeline can identify circumstances that, if not mitigated, could lead to major problems both within the pipeline and downstream (FIG. 2). Inspection and monitoring technologies provide pipeline operators with the information and resources they need to accurately assess the functionality of their pipeline and perform proactive maintenance on "at risk" areas. Some of the more important aspects include:

- Monitoring operating pressure
- Inspecting the integrity of the pipeline externally and internally
- Monitoring depth of cover
- Properly calibrating monitoring devices
- Monitoring ground temperature and excavation activities

Training and education. Pipeline controllers are responsible for operating expensive pipeline assets, and they should be properly trained, and even achieve certification. Instructing operators on what to look for in a gas leak is an important preventive step. Education among residents living along the pipeline can also help avoid

problems. Operators and civilians alike can benefit from the various tools that are becoming increasingly available. Computer-based simulators improve operational safety and meet regulatory requirements. Enabling the most realistic training experience is essential to ensuring that the pipeline controller is exposed to both normal and abnormal operating conditions.

Detection. Activities and solutions associated with the detection of commodity releases play an important role in pipeline integrity. Numerous methods of detecting a pipeline leak exist, and these detection methodologies can generally be divided into two approaches—external and internal.

External-based gas pipeline leak detection has been practiced since pipelines were first used to transport fluids of all types. It involves surveying the external surroundings of the pipeline to detect any releases. External-based systems continue to increase in popularity due to their ability to detect even the smallest of leaks with a high degree of accuracy.

Internal-based gas pipeline leak detection systems examine conditions inside the pipeline. Detection is typically based on measurement readings at specific locations along the pipeline. More commonly known as computational pipeline monitoring (CPM), this methodology has been in use for only three decades.

Each pipeline is unique. No two pipelines are the same. Specific detection methodologies used for one pipeline may not be useful for another. For example, a pipeline company operating in remote areas can rely solely on internal-based systems, while a pipeline company operating in high-consequence areas (HCA) may have both external- and internal-based systems installed for the same pipeline. All detection methodologies have pros and cons, and it is vital to take into account numerous factors prior to selecting the appropriate detection methodologies, including length, elevation, HCA, environment, cost, etc.

Tackling the gas pipeline integrity challenge. Gas leaks can be incredibly costly. A company can lose tens to hundreds of thousands of dollars in product if a moderate or even minor leak occurs. This is also true for the environmental impact of an undetected leak.

While gas pipeline integrity can seem daunting, it should not be feared if proper steps of precaution are taken. Implementing a tiered methodology significantly improves the chances of preventing, detecting and mitigating leaks in the first place, while providing additional benefits in other gas applications. ■



FIG. 1. Topographical and geological maps, satellite imagery, aerial photography and surveys should be utilized to evaluate the terrain surrounding a pipeline route.

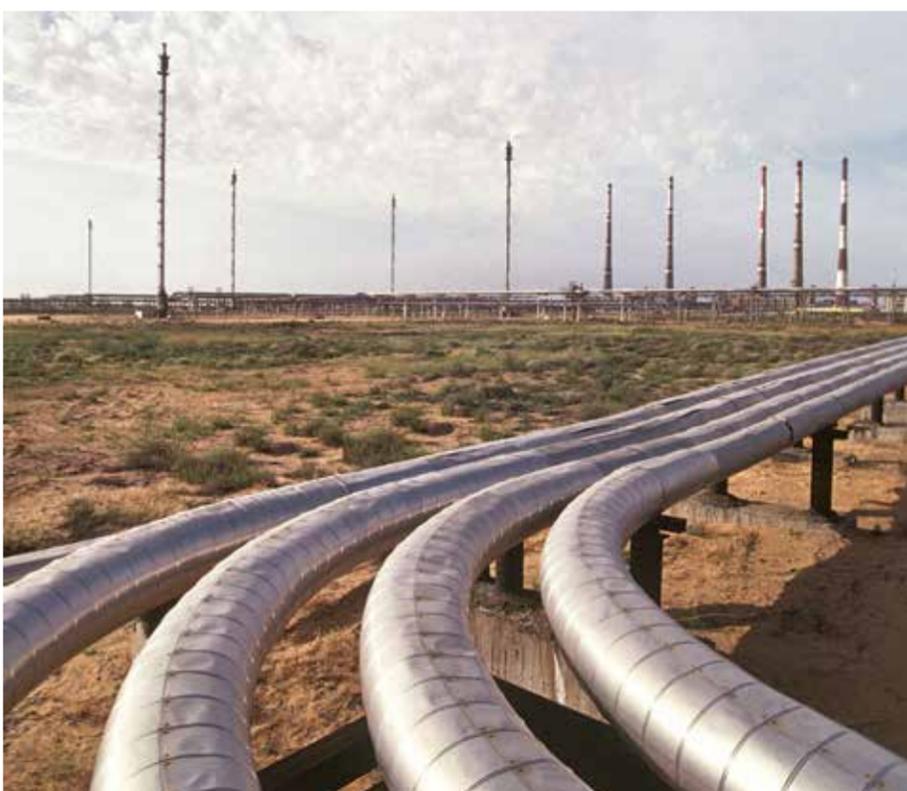


FIG. 2. Equipment construction and implementing a proper operations and maintenance schedule are major components of pipeline integrity.

New horizons for the LNG industry

MARTIN WOLD, DNV GL

With exciting new projects in the cruise industry and other segments, the past six months have been very positive for the LNG industry. With the impending 2020 global 0.5% sulfur cap, these developments give an indication of what is to come.

As of February 2017, 100 LNG-fueled ships are in operation globally, with 101 ships on order. Additionally, 72 LNG-ready ships—ships designed for efficient conversion from conventional fuels to LNG—are already in operation or on order (FIG. 1).

Whereas the LNG industry has been focused mainly on Norway, the order book is presently dominated by ships intended for operation in the North European and North American trades. Even without the necessary LNG bunkering infrastructure in place, LNG fuel is making its way into global ship trades. Seven of the vessels now in operation operate globally, and 19 of the newbuild orders are destined for global trade, as well. LNG bunkering infrastructure will be expanded as these vessels venture into new territories. LNG fuel has moved out of a niche market, and can be considered for all newbuilds and segments.

The LNG industry had high expectations that the introduction of the 2015 emissions control area (ECA) sulfur requirement would be remembered as the point in time when LNG fuel for ships really took off. The coinciding collapse of oil prices was naturally a disappointment to the supplier industry that had been investing

heavily for several years in R & D and sales activities. While many have felt that interest for LNG-fueled ships has reduced, DNV GL research shows that the number of newbuild orders has actually remained steady. Although the exponential growth we hoped for did not materialize, a steady stream of LNG-fueled newbuilds (particularly in a time of low oil prices and low newbuilding activity) provides some hope for higher growth rates in the future. The increased interest we now see in LNG as ship fuel supports this claim.

LNG uptake. When we look at the uptake in different ship segments, car and passenger ferries are still far in the lead. One reason is that LNG consumption and loading frequency often enable LNG distribution and bunkering by truck. In a time when LNG infrastructure is scarce, this flexible and low-CAPEX solution plays an important role. Distribution by truck can also be a cost-efficient solution in the long term, when the amount of required bunkering is limited in a certain area.

In the LNG uptake ranking, offshore vessels ranked as the second highest. However, with the downturn of the offshore market, further growth is expected to be low, for now. Overall, we expect to see the highest growth in the tanker, car/passenger, cruise and container segments (FIG. 2).

Container ships are well suited to be a forerunner for LNG fuel, with fixed routes and high fuel consumption to earn back the additional invest-

ment. Interest in LNG fuel has been relatively high for container ships for some time, and both dual-fuel engines and other novel solutions utilizing LNG fuel are being explored. Several major stakeholders have recently come together to carry out Phase 2 of the piston engine room free efficient containership (PERFECT) ship project, which investigates the possibility of using a combined-gas-and-steam turbine system (COGAS) to power an ultra-large container vessel (ULCS), shown in FIG. 3. The PERFECT project has brought together DNV GL, GTT, CMA CGM (and its subsidiary CMA Ships), ABB, the Caterpillar company Solar Turbines, and OMT. In Phase 2, which will be completed by mid-2017, the partners will detail the technical concept and its commercial feasibility.

The impact of LNG in the cruise industry. LNG as an alternative fuel is picking up in the cruise industry. Orders have been placed for 11 cruise vessels that will use LNG as ship fuel; this is just more than 10% of the present LNG order book. The first cruise ship to use LNG was the *AIDAPrima*, which operates on LNG in port. Royal Caribbean Cruises Ltd. has ordered two cruise vessels that will be powered by LNG and fuel cells. The ships will be built at the Finnish yard

Meyer Turku, and are scheduled for delivery in 2022 and 2024.

The recent developments in the cruise industry are important when the possible impact of newbuilding figures is considered. The recent orders for LNG-fueled cruise ships, for instance, will certainly affect the total volume of LNG sold to ships. Large cruise ships can easily consume 30 Mtpy–50 Mtpy (thousand tons per year) of LNG, depending on their operational profile. With 11 such vessels on order, the demand for LNG fuel will rise by approximately 300 Mtpy–500 Mtpy.

In comparison, DNV GL estimates that the total consumption of the fleet in operation is approximately 250 Mtpy, so decisions made in the cruise sector will have a significant impact on the whole industry. Such bunker volumes will give LNG suppliers the confidence to invest in additional LNG bunker vessels, which will likely be the preferred way of supplying these ships. These bunker vessels will increase LNG availability in certain regions, thereby benefitting LNG-fueled vessels in other segments and potentially leading to additional orders for LNG-fueled ships.

Outlook to 2020. By 2020, we expect between 400 to 600 vessels

See LNG INDUSTRY, page 12

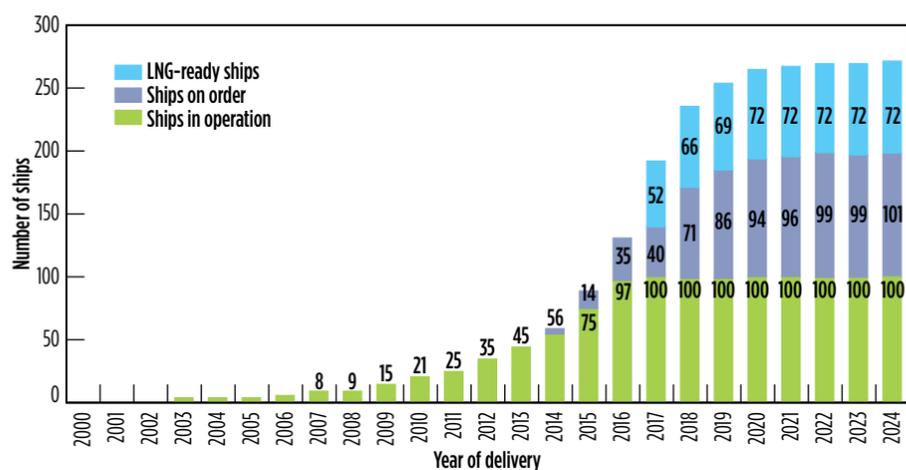


FIG. 1. The 201 confirmed LNG ship fuel projects include LNG-fueled ships in operation globally, ships on order and LNG-ready ships. Additional orders beyond 2018 are confirmed.

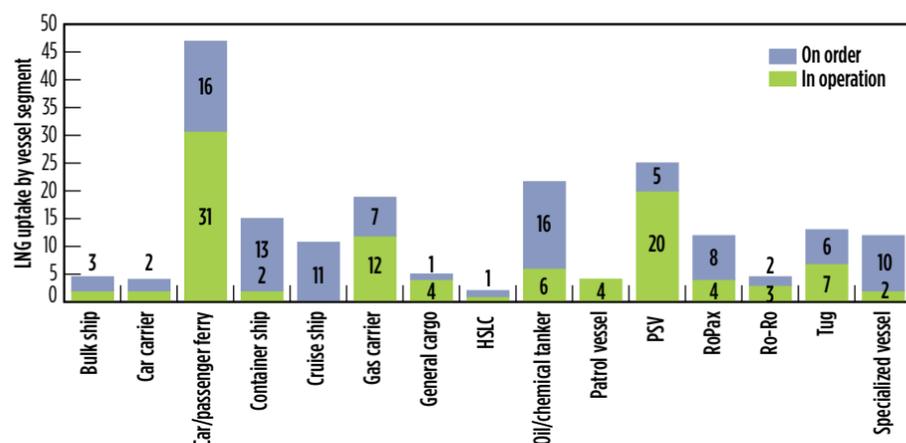


FIG. 2. LNG uptake by vessel segment.

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MENA: A top LNG growth target

MUSTAFA ANSARI, Arab Petroleum Investments Corp.: APICORP

The Middle East and North Africa (MENA) region will continue to rely heavily on LNG in 2017 to meet regional power and industry demand.

Egypt and Jordan received their first LNG shipments in 2015; Kuwait and Bahrain are both looking to construct permanent import terminals; and Abu Dhabi has opted to import LNG via a floating storage and regasification unit (FSRU). Regional LNG importers seek to secure long-term supply deals, making the most of structural oversupply to lock in favorable pricing and flexibility.

MENA gas demand. The MENA region's reputation as a supplier of global energy obscures a looming domestic supply crunch for natural gas, which will be mostly met by LNG imports. By 2018, MENA countries

will account for 6.5% of global LNG demand, a sharp rise from approximately 1% in 2013. Market conditions (an abundance of cheap supply) will also encourage MENA countries to think more strategically about the role of gas in their energy mix (FIG. 1).

Kuwait was the GCC's (the Cooperation Council for the Arab States of the Gulf, originally known as the Gulf Cooperation Council) first LNG importer, and that country is committed to building permanent LNG import infrastructure to meet its needs.

In 2014, Kuwait National Petroleum Co. (KNPC) signed a five-year contract with Golar LNG to charter an FSRU with an import capacity of 7.9 Bcmy (billion cubic meters/yr). Kuwaiti imports averaged 4.1 Bcmy in 2015, and will likely exceed those levels this year. In 2015, KPC

signed four-year contracts with BP and Shell, respectively, to purchase 1.36 Bcmy of LNG from each for 2016, and another four-year contract with Qatargas for 0.68 Bcmy. Kuwait also plans to build a permanent LNG import terminal in Mina Al-Ahmadi. The \$3.3-B terminal will have a processing capacity of 15 Bcmy, with the option of expansion to 30 Bcmy.

Dubai began importing LNG in 2014. Imports totaled 3.1 Bcmy in 2015, and are expected to exceed 4 Bcmy in 2017. Emirates LNG has put a hold on plans to install a 12.3-Bcmy LNG regasification and storage facility in Fujairah, opting instead to boost imports by chartering an FSRU in Ruwais that should come online later this year. This option takes advantage of cheaper prices and offers a flexible solution to meet power shortfalls until the United Arab Emirates' (UAE's) four nuclear reactors are completed in the early 2020s.

Bahrain produced 15.3 Bcmy of gas in 2015, a third of which was used for domestic power generation, as electricity demand almost reached the country's 4 GW of installed generation capacity. However, government plans to expand generation by 1.5 GW, and a proposal from aluminium producer Alba to build a 1.35-GW plant by 2019, will require an additional 3.3 Bcmy of supply. Bahrain's National Oil and Gas Co. (BANAGAS) has already signed a \$653-MM deal with Teekay LNG, Samsung C&T and Gulf Investment Corp. for the development of a 4.1-Bcmy LNG import terminal, to be commissioned in 2018 with an option to double capacity to 8.2 Bcmy.

North Africa LNG importers. In 2015, Egypt chartered its first FSRU from Norway's Hoegh, and a second from BW Group. In 1Q 2016, Egypt's imports reached 1.67 Bcmy, higher than the summer peak average in 2015.

The 2015 discovery of the massive 800-Bcm Al-Zohr gas field has provided hope that LNG imports can be contained. However, even if production from new discoveries reaches full capacity on schedule, domestic gas demand is still expected to outstrip supply by 2 Bcmy by 2021. Egypt has already launched a tender to lease a third FSRU with a capacity of 7.7 Bcmy, which could take total FSRU capacity to 21 Bcmy. Egyptian Natural Gas Holding Co. (EGAS) has signed contracts with suppliers to import up to 15 Bcmy by 2020 (TABLE 1).

Morocco imports 0.6 Bcmy of pipeline gas from Algeria, but the construction of a 2.4-GW combined-cycle plant (CCP) in Rabat will require imports of 3.5 Bcmy of LNG. Morocco's Office National de l'Electricité et de l'Eau Potable (ONEE) has issued a tender for the construction of a regasification terminal as part of its LNG-to-power project,

as well as tenders for the import of 2.7 Bcmy in 2020, increasing to 5 Bcmy by 2023. Morocco's reliance on renewables in the power sector makes its future LNG demand difficult to forecast, and ONEE plans to purchase 20% of its requirements on the spot market.

Jordan: An LNG importer with options. In May 2015, Jordan began importing LNG after chartering the 7.5-Bcmy FSRU *Golar Eskimo* for 10 years. However, the prospect of imports through the Israeli gas pipeline from 2018 means that Jordan will not expand this LNG-import capacity. Noble Energy, which produces gas in Israel, has announced a \$500-MM contract to supply 2.2 Bcmy over 15 years. Delek and Noble are also considering a longer-term export agreement totaling 45 Bcm over a similar duration.

LNG remains Lebanon's only gas-import option after Egyptian gas imports via the Arab Gas Pipeline ended in 2010. In 2013, the government issued a tender to charter a 7.7-Bcmy FSRU, with imports expected in the region of 1.6 Bcmy in 2016, increasing to 4.8 Bcmy by 2022. This should replace the existing fuel oil used in power generation and save the country more than \$1 B/yr, but the lack of progress is likely to postpone plans until the end of the decade.

Opportunities and challenges. Lower domestic energy prices reduce the attractiveness of investments in long-term LNG import infrastructure. Capital constraints and LNG market uncertainties are pushing the trend for FSRUs as a temporary option to take advantage of low prices before considering more expensive, long-term options. In the longer term, however, confronting the gas challenge requires a pragmatic approach to domestic prices for gas (and power), allowing them to rise sufficiently to incentivize development of the region's considerable gas resources. The MENA region has not deployed sufficient investment to bring these reserves into production, while prospects for regional gas pipeline trade remain limited.

MENA countries will seek to reinforce gas security by prioritizing gas for the domestic market, and by creating import infrastructure and capacity (FIG. 2). Low spot LNG prices, combined with FSRUs, offer a welcome quick fix. A swathe of import tenders from Egypt and Jordan in the past two years are a positive step toward energy security. Diversified imports in Dubai and Kuwait show that under today's market conditions, MENA importers can meet seasonal demand increases. Favorable market conditions should incentivize new MENA importers to install import infrastructure and sign cheap and flexible LNG deals. ■

TABLE 1. MENA LNG tender 2015-2019

Buyer	Seller	Cargo numbers	Period
Dubai	Centrica, Gazprom	3	2016
Egypt	Rosneft	24	2015-2017
Egypt	EDF, Gas Natural, Noble, PetroChina, Shell, Trafigura, Vitol	45	2015-2016
Egypt	NA	2	2016
Egypt	Trafigura	4	2016
Kuwait	NA	1	2016
Jordan	50% Shell	78	2016-2019
Open LNG tender			
Dubai	DSA	12	2016-2017

Source: APICORP

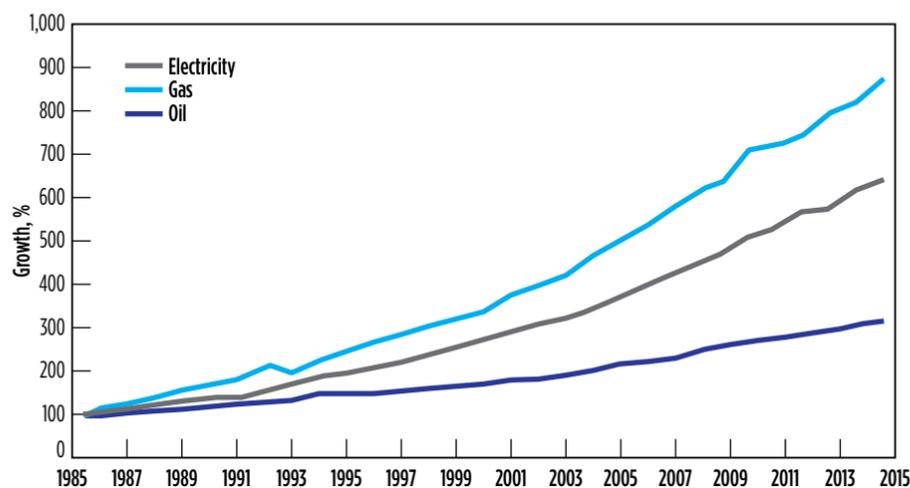


FIG. 1. MENA energy demand growth since 1985, %. Source: BP Statistical Review of World Energy, 2016.

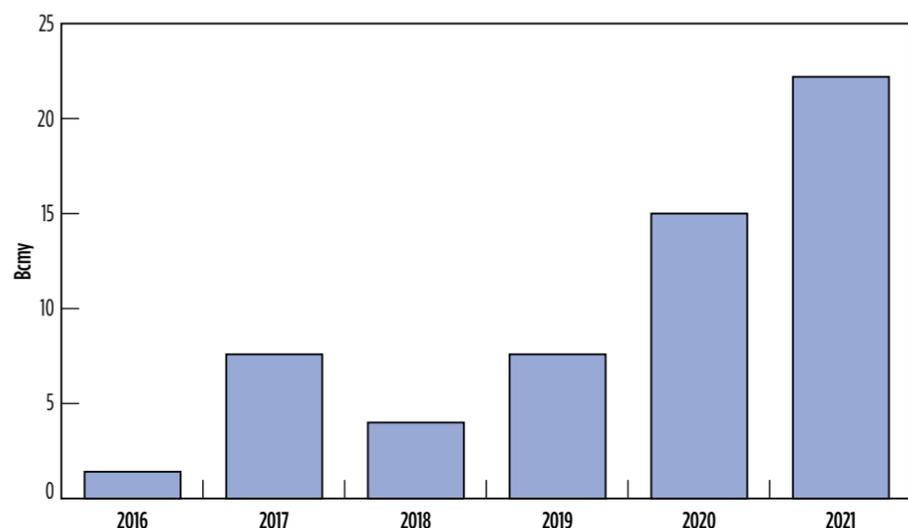


FIG. 2. MENA planned regasification additions, 2016-2021, Bcmy. Source: APICORP.

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Digital technologies reshaping marine prospects in uncertain waters

TIM SCHWEIKERT, GE Marine Solutions

The beginning of each year is a time to reflect on the last. The offshore and marine industry can look back on 2016 as one of the most bruising in recent memory. The downturn has been tough and drawn out, with increased divestment, more stringent environmental regulations and a prolonged shipbuilding cycle that has resulted in overcapacity.

However, challenges can be harnessed as a force for progress. The downcycle has pushed the industry to reshape its competitive landscape, a change that is likely overdue. Looking forward, 2017 will not be an easy year; but recovery is on the horizon, and this year will be a time for critical decision-making and forward thinking.

Ensuring fleet readiness will be

crucial, including how and when stacked assets can be cost-effectively reactivated. Ensuring optimal fleet performance to control costs and comply with environmental regulations—while reducing the level of reporting, where possible—will also remain at the top of the agenda for most ship-owners and operators.

tion-based maintenance, saving significant maintenance expenditures. Insights on the performance of a critical piece of equipment allow tailoring maintenance to a specific piece of equipment. This ensures that maintenance actions are only implemented when needed for optimal reliability and reduced lifecycle costs.



FIG. 1. Software analytics enable vessel operators to anticipate and address problems before they cause an operational disruption.

Timing is everything. In a market that is still volatile, the timing of these decisions will be a challenge. As an industry, the worst-case scenario is that we are unprepared to make these decisions, or that we are inadequately equipped to run with opportunities as the market recovers. As the industry moves toward a new “beginning,” the time truly is right for the digital revolution in offshore. Digital solutions help to de-risk decisions; bring practical, actionable insights into vessel and fleet performance; and provide proven opportunities to optimize operations in a sustainable way.

Breaking down data silos and data complexity are the first crucial steps. Through embedded sensors that enable the collection of data on critical vessel systems (FIG. 1), it is now possible to gain insights on future performance using software analytics. By analyzing these insights, vessel operators can anticipate and address problems before they cause an operational disruption.

Thanks to advanced algorithms and a strong data-processing capability, digital analytics tools can map out a “digital twin” of a physical asset—be it a propulsion motor, an engine or an entire vessel—based on its normal operational data profile. Drawing a comparison between the “digital twin” and the vessel’s real-time data, digital software can spot inefficiencies as well as detect potential failures, up to weeks in advance. This gives operators time to proactively mitigate potential problems, enhancing a vessel’s operational efficiency through reduced downtime and increased productivity.

This predictivity will also enable the industry to switch from calendar-based planned maintenance to condi-

Maximizing connectivity. The access to real-time insights from vessels enables onshore experts, no matter where they are, to remotely diagnose problems and immediately advise on the next steps. This approach not only provides vessel owners with fast access to global knowledge experts, but can also save significant amounts of time. For example, an engineer can analyze and diagnose multiple ships concurrently from a centralized control center, reducing the need for multiple specialists onboard. With the backdrop of a looming industry skills shortage, this connectivity maximizes the reach of an individual’s expertise and can ease the impact of downsized teams.

Data analytics tools also enable energy-efficient operations, as software can forecast weather and wave conditions, helping determine the heading and operational mode with optimized fuel consumption, a crucial advantage in complying with increased environmental regulations.

With the objective of capitalizing on this emerging digital opportunity, GE has developed its SeaStream™ Insight asset performance management solution. Working in collaboration with Maersk Drilling, GE will help deploy SeaStream Insight on one of Maersk Drilling’s rigs with the aim of increasing productivity through big data and reducing maintenance costs by up to 20%.

This partnership is a prime example of how digital technologies are shaping the future of the offshore marine industry. Uncertainty may be the new norm in the marine industry, but through digital technologies we can seize the opportunity to lead the transformation of the marine industry. ■

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ROSNEFT TO SUPPLY 10 LNG CARGOS TO EGYPT

A trading unit of top Russian oil producer Rosneft Trading SA (RTSA) has signed a deal to supply 10 LNG cargos to the Egyptian Natural Gas Holding Company (EGAS), according to a report by Reuters. The first delivery by Rosneft is expected in May. RTSA delivered three LNG cargos to Egypt in 2016.

Once an energy exporter, Egypt has become a net importer due to declining oil and gas production and increasing consumption. The country is working to increase production at recent discoveries to fill its energy gap as soon as possible.

Rosneft does not produce its own LNG yet, but plans to launch production jointly with ExxonMobil later this decade. The company declined to comment on the sourcing of the LNG cargos for Egypt. ■

Trends in LNG technology: A conversation with Shell's Guy de Kort



Gastech had the pleasure of interviewing Guy de Kort, Vice President of Development, Integrated Gas at Shell, about the dominant trends in LNG technology, Shell's LNG projects and his predictions for the gas industry in the next seven to 10 years.

Gastech: What are the main trends in LNG technology, and where (what markets) can these technologies have the most impact?

Guy de Kort: The global LNG market is growing and diversifying, with more countries importing LNG, more buyers emerging in existing LNG import countries, and more market segments. Shell's focus is on technologies that improve existing facilities, open up new markets for LNG and lower greenhouse gas emissions.

We are helping to improve the performance and efficiency of the LNG plants that we advise, to get more from these existing assets. This can be through debottlenecking and maximizing availability and reliability, but also through the implementation of improved technologies. We are actively developing new markets and new outlets for our gas, particularly in the marine and heavy road transport segments.

Although we have slowed the pace of new investment, we still see a place for large LNG projects in the future. So, we are using this time to optimize technology designs and integrate new ideas where they can reduce costs and improve efficiency.

Gastech: How has Shell LNG technology evolved since it began in the 1960s?

Guy de Kort: Shell is extremely proud of our long—more than 50 years—history in the development of LNG. Our deep understanding of LNG means that we are a reliable partner that is able to deliver better advice and integrated solutions.

In operating LNG facilities, we are driving the adoption of new technologies to improve operations. An example is Shell Smart Connect, which allows remote analysis of key equipment and condition monitoring, potentially lowering equipment failure rates.

In regasification, Shell has developed a new high-pressure emergency release system (HP ERS) to isolate, depressurize and disconnect the gas supply quickly and reliably in an emergency situation.

In LNG for transport, we work with original engine manufacturers on LNG engine performance. We are also part of a joint industry project that is developing a new “octane number” for LNG, potentially leading to increased engine power, lower fuel consumption and improved engine availability and safety.

Gastech: How are Shell's LNG projects moving forward?

Guy de Kort: Given today's environment and new supply coming to market, we have slowed the pace of new investment decisions and are reshaping projects for better returns. However, we continue to progress a diverse funnel of competitive opportunities for both greenfield and brownfield LNG.

Gastech: How will the global gas and LNG industry develop in the next seven to 10 years?

Guy de Kort: The significant drivers that will shape our industry are relatively well known: a growing population coupled with a higher quality of life are driving higher energy demand. Governments, business and society expect this energy to contain less CO₂. This results in a robust demand outlook for gas—and specifically LNG—and a transition to a lower carbon energy system.

However, no LNG project is developed overnight: most have a lead time of more than four years. If viable new projects are to come onstream over the next decade, costs must be addressed.

Simplification and standardization are at the top of my list. We can help our contractors to bring their costs down by using industry standards, and by addressing complexity.

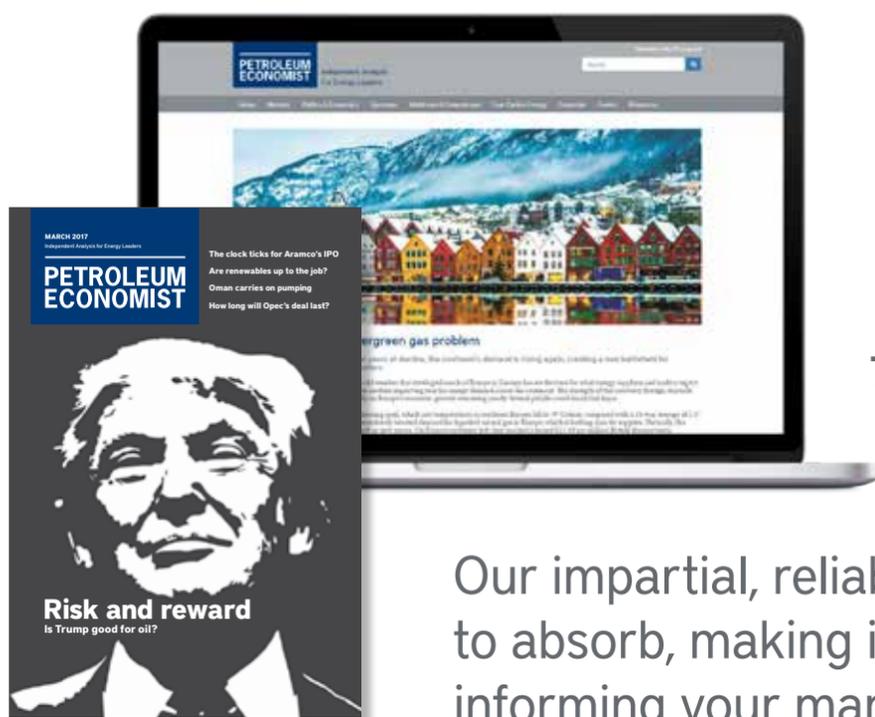
Gastech: As a member of the exclusive Gastech Governing Body, what are you most looking forward to at Gastech 2017?

Guy de Kort: For me, it is the opportunity to meet with people across the industry. Gastech brings a wide range of stakeholders together, so it is a great forum for sharing ideas and inspiring creativity. I am looking forward to hearing ideas that will deliver more and cleaner energy through the coming decades.

On Tuesday, 4 April at 10 a.m., Maarten Wetselaar, Integrated Gas & New Energies Director for Shell, will deliver a Global LNG Leader's Address.

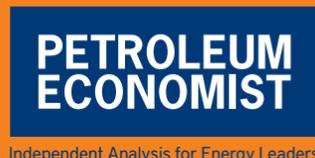
Guy de Kort chairs the Operations, Maintenance and Reliability panel on Wednesday at 2 p.m. Explore the new high-pressure emergency release system design at the Shell exhibition stand (M 202, 203, 204, 205). ■

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LNG INDUSTRY, continued from page 7

to be in operation worldwide. It will be interesting to see how the International Maritime Organization's (IMO's) recent decision to implement the global 0.5% sulfur cap from 2020 affects the LNG industry. We expect the price of the 0.5% fuel to be somewhere between the price of heavy fuel

oil (HFO) and marine gasoil (MGO). This will offer an additional incentive to ship owners that are considering a switch to LNG to achieve compliance with the upcoming sulfur cap.

The impact of increased interest in LNG as ship fuel and a greater number of newbuilds using LNG propulsion

will be felt the most in the deepsea ship segments. The application to the IMO for a nitrogen oxide (NO_x) ECA in the Baltic and North Sea (keel laying date of January 1, 2021) received somewhat less attention after the 70th session of the IMO Marine Environment Protection Committee (MEPC70), but this will be an additional regulation in favor of LNG over regional alternatives.

Exhaust gas cleaning technologies are also on the rise. Already, 354 scrubber projects have been confirmed (as per February 2017), and we believe that the uptake will increase over the next few years (FIG. 4). Scrubbers are a feasible and financially viable solution for existing vessels—thus far, approximately 70% of the confirmed scrubber projects have been retrofits. On the newbuild side, LNG is in the lead. The option that best fits a particular vessel must be determined on a case-by-case basis. Both solutions will play a significant role in determining the global fuel mix in the years to come, and the pace at which LNG infrastructure develops is one of the deciding factors for the success of LNG as ship fuel.

LNG bunkering infrastructure.

Our view is that LNG availability for ships is better than the industry's perception, and statistics from our LNG intelligence portal (LNGi) show that LNG bunkering infrastructure is developing rapidly. In total, 58 LNG supply locations are already in operation for ships globally, not counting LNG bunker vessels and LNG trucks, which can go anywhere (subject to permits). Investment decisions have been taken on an additional 36 projects, and a further 36 projects are registered as being discussed. Not all project ideas are available to the public, so the actual number is higher. In most cases, project initiators are trying to aggregate sufficient demand or confidence in the market to make an investment decision.

As for LNG-fueled ships, we clearly see that the majority of LNG bunkering projects under development are in Europe, mostly concentrated around the ECAs. We also see quite a few projects developing in Asia, but many of these are for inland waterway shipping. In North America, the pace of development has been somewhat slower than we expected, especially

when compared to what we are seeing in Europe. The slowing effect of the lack of infrastructure developments, among others, should clearly not be underestimated.

In these early days, flexible infrastructure assets make sense. Orders for LNG bunker vessels are clearly picking up, and such vessels will play an important role for cost-efficient distribution and bunkering of LNG. Five LNG bunker vessels are on order, including orders by Shell, Engie/NYK/Mitsubishi, Skangas, Bomin-Linde/Klaipedos Nafta and TOTE/JAX LNG. In September 2016, new developments in terms of bunker vessel design were seen when DNV GL awarded Vard Engineering Brevik AS with an approval in principle (AiP) for its new 6,500-m³ bunker vessel design.

Vessels can now load LNG at six bunker ship loading facilities globally; another nine have already been decided upon, and a further five are under discussion.

LNGi. With rapid industry growth, it has become increasingly challenging to keep track of all the latest developments. This led us to develop the DNV GL LNG intelligence portal (LNGi). Launched in March 2016, the portal brings stakeholders from across the LNG industry together to share market intelligence and contribute to the uptake of LNG as a ship fuel. Leading LNG suppliers and engine manufacturers—including Shell, the marine division of Rolls-Royce and MAN—were some of the first companies to subscribe. LNGi allows subscribers to assess the availability of LNG fuel for specific trade routes and newbuild projects. It also provides information about market developments and status updates of other alternative fuels and emissions reduction technologies across every vessel segment.

It is difficult to remain up-to-date on this kind of information, but it plays a significant role in making investment decisions. LNGi allows us to pool our collective efforts to generate high-quality data and increase the transparency in a market that is set to receive multi-billion USD investments in the coming years. In this way, we can innovate together, and with much greater speed and impact than we could hope to achieve working alone. ■



FIG. 3. Phase 2 of the PERFECT ship project investigates the possibility of using a combined gas and steam turbine system (COGAS) to power a ULCS. Source: DNV GL.

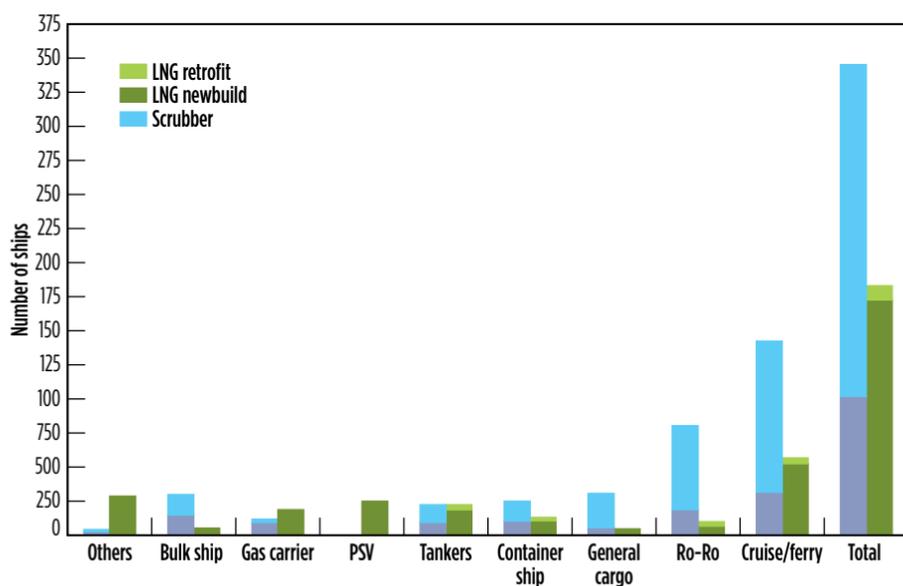


FIG. 4. Investments in scrubbers are higher in total numbers, but LNG fuel is the most frequent choice for newbuilds.

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GTT TO EQUIP NEW HYUNDAI HEAVY INDUSTRIES' LNG CARRIER

GTT has received an order from Hyundai Heavy Industries to equip a new LNG carrier with its Mark III Flex containment system. Hyundai's shipyard based in Ulsan, South Korea will build the 180-Mm³ (thousand cubic meters) vessel on behalf of the Norwegian shipping company NORSPAN LNG XI AS (Knutsen). Delivery is scheduled in 2019.

Knutsen is a long-standing owner of LNG carriers equipped with membrane technology. With 10 vessels of this type, Knutsen is "renewing its confidence" in GTT technology by choosing Mark III Flex for this new vessel.

With its Mark III Flex containment system, GTT provides an insulation solution that is able to reduce the daily guaranteed boiloff gas rate to 0.085% of tank volume. The Mark and NO ranges have been designed to meet all transport and storage requirements of liquefied gases. ■

FSRU concepts meet evolving energy demand

The ability to deploy floating storage and regasification units (FSRUs) to meet local power generation demand has gained pace, as new and different vessel concepts—often serving different parts of the value chain—have made their way into the marketplace.

An FSRU typically has a larger storage capacity than the discharging carrier. As the size of LNG carriers has grown, older LNG carrier tonnage has been rendered too small for standalone FSRU conversion. This has paved the way for multiple units, or even a barge alongside, with a mounted FSU or FSRU system.

Another element that encourages the use of floating LNG storage units rather than complete FSRUs is seasonal demand. Placing the regasification unit onshore, or on the jetty, and using an LNG carrier for storage is a simple solution.

“Today’s overcapacity in the LNG market is leading owners to look creatively toward new solutions for how to best utilize their assets,” said Tor-Ivar Guttulsrød, Director of FSRU and FLNG, Global Gas Solutions at ABS. “This process also typically involves class, both as a discussion partner and, most importantly, to ensure that any new concepts are in line with applicable rules and regulations (FIG. 1).

“Because most LNG demand is driven by the need for electricity generation from a low-pollution source, a concept that has been widely discussed and may see a significant market in the future is a combined FSRU and floating power generation plant.”

An additional factor driving FSRU or FSU conversions is the availability of ships in the conventional LNG-size segment, which are still comparatively young. This “middle-aged” tonnage is not as efficient as newer vessels, given the improvements that have taken place with propulsion and containment systems on newer ships.

The use of barge-based regasification units is a concept many industry players, such as ABS, are investigating due to their potentially multiple applications. A unit with some storage and regasification kit onboard could effectively combine with an older and somewhat smaller FSU to provide the functionality of a large-scale FSRU, while also allowing the larger storage unit to trade as an LNG carrier during a low season with little or no gas demand.

A second, and apparently fast-growing, segment of the market is for barges to serve as regasification units for the small- and mid-scale segment. Units with a typical storage volume of 10 Mm³–25 Mm³ are becoming

increasingly popular. These units can serve a smaller power station in an island nation—or any other remote location—and can be easily served by small-scale LNG carriers.

While full-scale LNG-to-power

ships have not yet been ordered, this concept is being developed by several top industry players, and is expected to gain prominence moving forward, with stronger growth in clean-burning electricity supply. ■



FIG. 1. Today’s overcapacity in the LNG market is leading owners to look toward creative new solutions for how to best utilize their assets.

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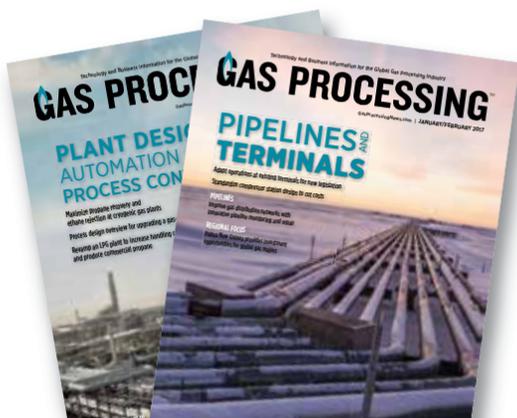
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Welcome to the Land of the Rising Sun

MIKE RHODES, *Gas Processing*

Perhaps more than any other country, Japan embodies the combination of a deep respect for ancient cultural traditions with a national identity of forward-looking, cutting-edge technology.

The Japanese archipelago stretches some 1,900 mi from north to south, contains approximately 40 active volcanoes and experiences 1,000 earthquakes a year. The steep, craggy mountains that cover two-thirds of the country have forced the Japanese to utilize every acre of land, and rich volcanic soil along the coastal plains and long growing seasons are able to support the density of the population.

Cultural quirks. Every culture has its own idiosyncrasies that set it apart, and these small differences are what make traveling so rewarding. Japan is certainly no exception. On escalators, stand on the left and walk on the right, which is simple enough but the opposite of Europe and the US. Smoking, eating and drinking while walking through Tokyo's crowded sidewalks is a considered a digression. Responding to the resounding, "Irasshaimase" ("Welcome") that greets shoppers at every turn, or returning the early-morning bow that greets the first customers of the day is not necessary. Because service charges are built into a restaurant bill, leaving tips is not only unnecessary, it is considered insulting. Don't worry, service is excellent.

Despite the orderliness that guides everything else in Tokyo, bicycles seem to have free reign of the city's sidewalks. However, the wide paths winding beneath exploding cherry trees in the parks can only be enjoyed on foot. Trash cans are rare, so if you generate garbage in your wanderings, be sure to carry it with you.

Money is not handed directly to cashiers in restaurants or retail outlets, but rather exchanged in a small tray near the register. If you exchange anything of value (like a business card or credit card), hold it with both hands and deliver it with a small nod. This demonstrates that both parties respect both the item and each other enough to entrust it to the other.

A visitor's natural inclination when someone does a small favor—holding open a door, or giving up a seat on the subway—is to say, "Thank you," or "Arigato." A more natural and Japanese thing to say is, "Sumimasen," a most useful word that means, "Sorry," or, "Excuse me," or something like, "Sorry to inconvenience you."

On long-distance trains and subways, talking loudly on your phone is widely discouraged, and hearing chimes and ringtones is rare. Most people keep their phones on vibrate. The Japanese are polite, friendly and welcoming, and the atmosphere in Tokyo reflects that.

Japan's national sport. Sumo wrestling originated in ancient times as a performance to entertain Shinto deities. The rules are simple: the wrestler who exits the ring first, or touches the ground with any part of his body besides the soles of his feet, loses. Matches, which take place on an elevated ring made of clay and covered in a layer of sand, are usually over in a few seconds of furious close combat. Because weight restrictions or classes do not exist, wrestlers can easily find themselves matched against an opponent many times their size, so weight gain is an essential part of sumo training.

The pre-match pageantry and contests are highly ritualized (FIG. 1), such as the symbolic purification of the ring with salt. A strict hierarchy exists among competitors, and their tournament performances throughout the year either promote or demote their rankings.

Cuisine. Japanese food has its own unique flavor, and Tokyo offers some of the best. Let's just come right out and say the magic word—sushi. Vinegared rice and raw fish are only the beginning, as master chefs create an endless variety of Japan's most famous food and serve it beautifully on wooden or lacquer plates (FIG. 2).

Sashimi is fresh, raw seafood or meat that is thinly sliced and served with soy sauce and other ingredients. Ramen is an affordable, staple dish and is prepared a variety of ways. In Tokyo, ramen consists of thin, curly noodles served in a chicken broth and flavored with soy, usually topped with sliced pork, egg, spinach and nori. Making slurping sounds while eating ramen with your chopsticks is common, polite and an expression of appreciation.

Another traditional Japanese food, tempura, is made with vegetables, seafood and other ingredients, all battered in eggs and flour and then fried in vegetable oil to form a crispy texture. Sukiyaki is often cooked at the table in a Japanese hot pot style (nabemono). The most common ingredients used in Tokyo include vegetables, tofu and negi, which are added to the beef and cooked, mixed with soy sauce, sugar and mirin. To soak up the broth, boiled udon or soba are sometimes added.

Soba is a type of noodles made from buckwheat flour. Opinions on how to best enjoy soba differ, but chilled or cooked as a noodle soup are the two most popular. Udon is quite similar to soba, but made from wheat flour. As with soba, it can be served either cold or hot. The simplest hot dish is made in a broth called kakejiru, which can be topped with scallions or prawns.

Okonomiyaki, which roughly translates to "whatever you like grilled," is a pancake filled with almost anything—mostly pork, shrimp or cabbage—and covered with mayonnaise, sauce and dried seaweed.

Chankonabe, a hot pot dish made from chicken-based broth, vegetables, tofu and/or fish, was originally cooked for sumo wrestlers to accommodate their weight gain diet. Miso soup is a cornerstone of a nutritious local breakfast. It consists of dashi, a stock with miso paste. Tofu is also usually added and, depending on the recipe, vegetables, meat and seafood can be used as well.

With your meals, enjoy one of Japan's renowned beers, or try some sake, a rice-based wine that should be served either lukewarm or heated in small shots called "choko." The city is full of flavors, so be sure to sample as many as you can.

Off the beaten path. Tokyo offers many traditional experiences for visitors, such as the Imperial Palace and its gardens (FIG. 3); the fastest and most modern high-speed "bullet" trains in the world; and dozens of temples and shrines, both Buddhist and Shinto. Explore a little off the beaten path for a deeper understanding of the city and its people.

One of Tokyo's most interesting coffee shops, **Omotesando Koffee**, hides in plain sight in an inconspicuous traditional wooden townhouse. Japan's **oldest amusement park**, Hanayashiki, was fully developed in the late 1800s during the country's industrial revolution. Today, this densely packed park boasts 22 attractions, including Ninja and kimono demonstrations and daily music performances. The

morbidity curious among us might find themselves drawn to the 60,000 specimens on display at the **Meguro Parasitological Museum**, the only of its kind in the world.

The narrow streets of **Golden Gai** contain more than 200 micro bars, restaurants and izakayas, attracting an eclectic crowd. **Jinbocho**, nicknamed Book Town, is home to roughly 180 book-related businesses and is Tokyo's publishing hub.

Not far from the **Kanda Myojin Shrine** is the **Akihabara** district, nicknamed Electric Town for its status as Tokyo's technology hub. It is only fitting that the more gadget-inclined are welcome to receive blessings and protections for all their electronic goods!

Piss Alley (Shomben Yokocho)—so named for its previous lack of facilities—or **Memory Lane (Omoide Yokocho)** is home to more than 60 ramshackle bars and closet-sized food stalls. **Robot Restaurant's** cabaret show is a spectacle that can only be likened to a live action video game, featuring loud techno music, taiko drumming and garishly bright light displays. **Shimokitazawa**, or **Shimokita**, is a small district popular with Tokyo's young and trendy. A bargain hunter's dream, Shimokita is best explored on foot to experience the quirky shops selling secondhand clothing, vintage records, and rare and unusual things that you won't find anywhere else.

Make sure you step away from business at Gastech 2017 and get out into the city. Tokyo is waiting for you. ■



- 1 The Imperial Palace provides a calm and peaceful oasis in the middle of a bustling city.
- 2 Gastech attendees should not go home before experiencing sushi in its homeland.
- 3 Japan's national sport, sumo wrestling, is highly ritualized and fiercely competitive.



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