# Gastech

The Official Show Daily Exhibition & Conference Newspaper



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### Women in Energy: Driving diversity for success

**ADRIENNE BLUME, Gas Processing** 

Day 3 of Gastech saw the return of a very important, very successful, event addition to the Gastech Exhibition and Conference. First launched at Gastech Singapore in 2015, the Women in Energy (WIE) program provides a platform for the discussion of challenges, successes and opportunities in achieving gender diversity, as well as a forum for networking and mentoring.

This year's program theme, "Driving diversity for success," is fundamental to the future of the gas industry, and highlights the importance of leveraging the benefits and resilience that diverse teams bring to organizations. WIE 2017 sponsors include KPMG, NextDecade, Pertamina, SNC Lavalin and Yokogawa.

The full-day program's morning session included welcoming remarks from WIE Chairperson Barbara Jinks, Program Manager for Gastech Women in Energy for dmg :: events and Marketing Manager for International Gas Union. Diversity is becoming an increasingly important topic across business organizations and at industry events, Ms. Jinks acknowledged. "Diversity is about creating intelligent, considerate, inclusive and relevant teams," she said. "It just makes business sense."

Ms. Jinks also mentioned that less than 20% of the global oil and gas workface is made up of women. At the senior level, this portion falls to less than 10%. "We need to raise awareness on these issues," she said. "I hope we all leave this room having learned a little more about the successes and challenges of diversity—but particularly the successes."

**Evolving roles of women in energy.** Noriko Endo, a prominent expert in energy and environmental policy at Keio University in Minato, Japan, delivered the WIE program's opening keynote address. Dr. Endo leads monthly roundtable discussions with 30 women leaders in the Japanese industrial world, to discuss energy security and environmental responsibility, as well as socioeconomic and geopolitical issues related to energy.

Dr. Endo spoke about why she decided to organize a women's meeting to discuss these issues. She said that most the women in her group have said they do not feel that their gender has been a factor in their work, or in how



Women in Energy panelists included moderator Kerry Anne Shanks, Head of

they are treated at their companies. However, they acknowledge that their industries are still dominated by men.

"Why *shouldn t* women lead energy policy discussions, if energy is an indispensable facet of everyday life?" Dr. Endo posited. Since the Fukushima nuclear disaster, she acknowledged that women have become much more involved in discussing energy issues. In Japan, women also are finding it easier to attain leadership and executive positions.

A gender pay gap still exists, however. Dr. Endo acknowledged that women earn 72.2%, on average, of men's salaries. The types of employment traditionally sought by women and men may be a reason for this disparity, she said. Approximately 66% of general labor is performed by men, while the majority of part-time work (more than 70%) is done by women. However, women's roles in the labor force are being emphasized by the Japanese government, considering the country's population decline.

"I feel this is the time for women to make a difference. This is a crucial moment, where new ideas are urgently needed," Dr. Endo said in closing. "I sincerely hope that efforts made by Gastech and Women in Energy will have an important effect around the world, and that these connections will be made organically."

Working for gender equality in industry leadership. Dr. Endo's address was followed by a panel discussion on championing gender diversity in the workplace, and engaging with

### Friday, 7 April 2017

**DAY FOUR** 

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Gas and LNG Research for Asia-Pacific at Wood Mackenzie; Maarten Wetselaar, Integrated Gas and New Energies Director at Shell; Yenni Andayani, Director of Gas and New and Renewable Energy at Pertamina; and Robert S. Franklin, President of ExxonMobil Gas and Power Marketing Co. leadership around the world. Panelists included moderator Kerry Anne Shanks,

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Taiwan and Australia.

South Korea, China,

15 Scenes from Gastech Tokyo



### Progress powered by natural gas

As technology unlocks resources previously considered too difficult or costly to produce, the prominence of natural gas in the global energy mix will continue to grow. Total worldwide gas demand is projected to increase by about 45 percent by 2040, with growth seen in every sector, particularly power generation – where natural gas emits up to 60 percent less carbon dioxide compared to coal.

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### **Conference Program**— Friday, 7 April 2017

#### Part 1: Engineering, Procurement and Construction-**Project Execution and Updates**

09:00-09:10	Session Chairs Welcome—with the Gastech Governing Body Co-Chairmen	
09:10-09:25	The "Young Gastech" Winning Essay Presentation The participants of the Young Gastech programme submitted essays examining key issues impacting the global gas and LNG industry. The winning paper—voted on and selected by the Governing Body Co-Chairmen—will be presented by the student to the final morning's audience.	
09:25-09:50	<ul> <li>LNG and the Great Reformation?</li> <li>Christopher Caswell, Director—LNG and FLNG, KBR</li> </ul>	
09:50-10:15	<ul> <li>LNG Project Developments of the Future; What are the Key Levers to Have Safe, Competitive and Affordable Project Delivery?</li> <li>Hilary Mercer, Vice President Integrated Gas Projects, Shell</li> </ul>	
10:15-10:40	<ul> <li>Steelhead LNG's "At-Shore LNG" (ASLNG) Project</li> <li>Nigel Kuzemko, Chief Executive Officer, Steelhead LNG</li> <li>Paul Hughes, Project Director LNG, WorleyParsons</li> </ul>	
10:40-11:00	<ul> <li>Vysotsk LNG: The Development of a Future Model for Russian LNG Projects</li> <li>Vladimir Smelov, CEO, Cryogas-Vysotsk</li> <li>Paul Hughes, Project Director LNG, WorleyParsons</li> </ul>	
11:00-11:20	Networking refreshment break hosted by ExxonMobil	
Part 2: Engineering, Procurement and Construction— Risk Management and Strategy		
11:20-11:40	Managing Technology Risk—an Owner's Perspective Tony Diocee, Vice President Projects, Jordan Cove LNG LLC	
11:40-12:00	Keeping EPC Mega-Projects on Track with Innovative Project Controls and Extreme Planning Russ Thompson, Major OEM Manager, Kiewit	
12:00-12:10	Session Chairs Closing Remarks	
12:10-12:40	Governing Body Co-Chairmen and Guests: Reflections and Summaries of the 2017 Gastech Japan Conference	
12:40	Close of Gastech 2017	



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Head of Gas and LNG Research for Asia-Pacific at Wood Mackenzie; Maarten Wetselaar, Integrated Gas and New Energies Director at Shell; Yenni Andavani, Director of Gas and New and Renewable Energy at Pertamina; and Robert S. Franklin, President of ExxonMobil Gas and Power Marketing Co.

Ms. Shanks opened by acknowledging that when she started her career, she was skeptical of the need for advocacy groups like WIE because, like Dr. Endo, she believed that she could carve out her career path on her own merits. However, Ms. Shanks acknowledged, "Everyone is aware of the sobering statistics. All you have to do is look around Gastech, and you can see that women are sorely underrepresented at the senior level."

Ms. Shanks then asked the panelists why women's advocacy and diversity are important to them, and to their companies. Dr. Wetselaar commented, "We've achieved many things as an industry, and achieving gender balance should be easy, but it's proven to be a slow process."

He noted, importantly, that gender equality encompasses issues not addressed specifically by the WIE program. "Some of it is about having gender equality in [national] constitutions, which isn't the case everywhere.

Some of it is about addressing violence against women-possibly even before addressing issues of women in the workplace." Dr. Wetselaar also acknowledged that gas industry development and gender equality development goals are linked. "Research shows that all companies that achieve gender equality have a much higher potential for success than those that don't."

Ms. Shanks then asked Ms. Andayani about the business and economic case for gender diversity. "Profitwise, there is proof that when you have gender diversity, companies grow faster and are more sustainable," Ms. Andayani said. "I believe that when you have more women in companies, then the companies do much, much better." She then added, "I personally think most women are more decisive than men." That comment received a round of applause from the mixed female-and-male audience.

Mr. Franklin noted, "Diversity is important for two reasons. One, it's the right thing to do. Secondly, for any company these days, there is a selfinterest component to this. Companies will perform better if they have a more diverse workforce and when everybody's contribution is valued."

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### Efficiency and cost savings dominate executive discussion

#### KURT ABRAHAM, World Oil

Delivering greater efficiency and cost savings through improved innovation and technology was the theme of Thursday's executive panel discussion during the commercial session. The executives participating were in basic agreement as to what should be done to bring about these changes.

First up was Rod Christie, President and CEO for Turbomachinery Solutions at GE Oil & Gas, who sounded some familiar themes that he has been touting during the last year. Mr. Christie has been advocating for standardization of technology, processes, documentation and approaches used by service companies and operators. He says this would enable operators, OEMs and partners to achieve their

mutual goals of controlling costs, mitigating risks, and bringing more speed and efficiency to all sectors of the oil and gas industry.

#### Digital transformation of

industry. One of the tools that Mr. Christie said will help with this implementation is the ongoing digital transformation of the industry. GE has put into place systems that enable various teams within the company to tap into the burgeoning waves of data that the digital transformation is generating. "Our teams can interact with each other, together, and share data through

While Mr. Christie represented the service company view, Enagas CEO Marcelino Oreja looked at the situation from the angle of being Spain's leading gas transmission company, which is now active in eight countries. In pursuing the goals of efficiency and quality of products, Mr. Oreja said that his firm is working to satisfy three aspects:

- 1. Affordability, which relates to keeping products and services cost-competitive
- 2. Sustainability, which
- concerns meeting the needs of communities while minimizing carbon footprint
- 3. Flexibility, which refers to the ongoing effort to look for new products and new markets.

In describing the task at hand, Mr. Oreja also set a goal for the entire

digital means," noted Mr. Christie.

Enagas CEO Marcelino Oreja stressed that his company was working hard on its digital transformation.

industry when he said, "We have to change the culture of our companies. We have to change the way we work." Echoing some of Mr. Christie's comments, the Enagas CEO said, "We also are working very hard on the digital transformation of our company. This is very important."

#### Improving the E&P supply

chain. INPEX Senior Executive Vice President Masaharu Sano offered an upstream operator perspective. His comments quickly fell in line with the other panelists as he remarked, "We at INPEX are working on technology and innovation in our E&P activities to ensure extensive growth." He reminded attendees that his firm operates the largest gas field in Japan, and it also operates a 1,500-km pipeline network from the field to Tokyo.

Nevertheless, noted Mr. Sano, "We want to make our gas supply chain better." To that end, he explained that this task will be accomplished, like the others, by utilizing what he termed "The INPEX Way." This methodology installs a lean culture throughout the company's businesses, regardless of division, discipline or country. As Mr. Sano further explained, "A lean

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Alasdair Cathcart, President of Bechtel Oil, Gas & Chemicals,

espoused a theme of "building

efficiency through integration.'

However, this diversity must be built into companies. Dr. Wetselaar added that measuring progress in gender diversity requires that targets be set and checked at all levels. "If you leave



it to chance and don't set targets, then it's possible the diversity effort will not be met," he said.

at Dutch firm Vopak, focused his

access to markets.

comments on growth through better

Ms. Andayani commented that, at Pertamina, she has noticed that women stop developing in their careers at a certain point. They can rise quickly to management level, but then often stop there, due to family commitments or questioning whether further progress is achievable. Ms. Andayani believes that companies should help provide flexibility and accommodation for women who wish to progress in their careers and raise families at the same time. Both Dr. Wetselaar and Mr. Franklin agreed that greater efforts are needed to encourage girls and young women to pursue STEM careers. "If you can get technical universities to reach 50/50 [female and male participation in STEM programs], or to breach it, then you will have more women working in the industry." Dr. Wetselaar noted that this goal has been reached already in his home country of The Netherlands.

Overcoming educational and cultural biases. Other company

der equality is less well-developed, either in the industry or in society at large, establishing women's empowerment programs actually attracts a lot of women to our companies. The culture may not be enabling to women's empowerment, but creating a small cocoon within the company can enable that empowerment and diversity. He pointed to the Middle East as an example of a region where Shell is actively working to give women opportunities to develop their careers outside of cultural constraints. The director warned, however, that companies, "Must respect the starting point of local cultures when trying to bring about change, rather than working from the outside standpoint of gender equality; otherwise, you may end up taking a step back instead of moving forward."



Dr. Noriko Endo, a prominent expert in energy and environmental policy at Keio University in Minato, Japan, delivered the WIE program's opening keynote address.

efforts named by the panelists to encourage gender diversity and women's empowerment included familyfriendly policies for both female and male employees; giving opportunities to women entrepreneurs and womanowned businesses, where appropriate; attracting more women to STEM careers: and funding programs for women's career and learning opportunities in countries where gender inequality is a prominent issue.

Dr. Wetselaar commented, "What we find is that in countries where gen-

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### Japan's rising interest in Southeast Asia gas and power assets

#### **GEENA CHATTERJI, Wood Mackenzie**

A wave of Japanese financial commitments was seen in Southeast Asia gas and power. Last year, Japan made up approximately 17% of the \$22.3 B of total investments in Southeast Asia power assets. Japanese utilities, in particular, have increased their activities in the region, as they are faced with a stagnant home market and the risk of declining margins as a result of liberalization.

Since April 2016, Japan's retail electricity market has been open to competition, directly impacting the leading utilities' core business of generating electricity and marketing it to end users. Data published by the Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO) in November 2016, indicated that in seven monthsfrom April to November 2016—more than 2 MM retail electricity customers switched suppliers. This loss in customers reduces the revenues and margins of the major power utilities.

In response to increased competition in its home market, Japanese utilities have been looking abroad to grow their businesses. Southeast Asia is a key region for Japanese investment mainly due to its growth potential, in power generation and other areas, including LNG (FIG. 1). Wood Mackenzie forecasts that power demand in the region will grow by 5% from 2016–2035, while regional LNG demand is expected to grow by 12% during the same time period.

The case studies presented here highlight opportunities that are being pursued by Japan.

Case study 1. On 31 January 2017, state-owned electricity firm Perusahaan Listrik Negara (PLN) signed a

25-yr power purchase agreement (PPA) with the Java-1 consortium comprising PERTAMINA (40%), Marubeni (40%) and Sojitz (20%). This project is the first and largest integrated LNG-to-IPP (independent power producer) project in the 35-GW power program.

The Java-1 PLTGU will have a total capacity of 1,760 MW, a 10% increase from its initial plan, and will supply electricity to PLN for 25 yr under the PPA with a price of \$0.055 per kilowatt hour (kWh). The facility will be operated as a load follower, with a minimum availibity factor of 60%.

Java-1 will provide a model for subsequent gas-fired IPP projects, such as the 500-MW Java-3 peaker in West Java, and the 800-MW Java-3 in East Java. The project represents Sojitz's first foray into Indonesian power, and strengthens Marubeni's existing position.

The project attracted strong interest from the private sector, particularly from Japanese players. Ten companies/consortia were pre-qualified, and four of them submitted bids. Apart from the Jawa Satu Power, other international contenders included the Mitsubishi-JERA-Rukun Raharja-PJB, Medco Energy-Kepco-Nebras Power and Adaro Energy-SembCorp consortia. The tender shortlist highlights the growing trend of Japanese interest in infrastructure development in Southeast Asia. As Indonesia continues to grow, Wood Mackenzie predicts that increased opportunities for foreign capital investments will continue to develop.

Case study 2. In July 2016, Tokyo Gas announced its plan to invest in a joint venture with PV Gas to develop the Thi Vai LNG regasifica-

#### **PREDICTION: GAS AND LNG** WILL REMAIN KEY ENERGY SOURCES

Japan imported 8.3 MMt (million tonnes) of LNG in January, an increase of 1.06 MMt over 2016, according to data released by the Japanese Ministry of Finance. Additionally, the amount the country pays for LNG imports has increased 6.7% since 2015.

It is expected that gas and LNG will continue to remain a key future energy source for Japan. The nation's reliance on LNG rose in 2011 following the tion terminal. PV Gas is the largest regasification terminal and review the shareholder with a 51% stake, while Tokyo Gas and Bitexco hold 10% and 39%, respectively.

This is the first Japanese involvement in building Vietnam's LNG infrastructure. The 1-MMtpy (millions of tons per year) Thi Vai terminal was originally scheduled to begin operations in 2017. The frontend engineering design (FEED) was completed by Tokyo Gas Engineering in 2013, but no decision was made to proceed with the construction of the terminal. In April 2016, PV Gas was informed by state-owned PetroVietnam to temporarily halt work on the

feasibility of the project. It was determined that progress could resume following the inclusion of Bitexco. As Vietnam pivots towards more gas in its fuel mix, Tokyo Gas is well-positioned to capitalize on this trend.

This report is an extract from Wood Mackenzie's Southeast Asia Gas & Power Service, which includes coverage of the gas and power markets in greater detail. The analysis includes supply, demand and pricing on a regional level, contract pricing information and extensive policy coverage. For more details, please visit the Wood Mackenzie exhibition at 12-050.



FIG. 1. 2016 power investments in Southeast Asia. Source: Wood Mackenzie.

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closure of the country's nuclear reactors, and growth has increased since then.

Koichi Wada, Division COO, Natural Gas Business Division of Mitsubishi Corp. said, "Natural gas has an advantage from environmental and supplydiversification perspectives, and could compensate if the targets of other fuels are not achieved. We see that natural gas could potentially have a higher share in the mix target of 2030, and the trend might continue until 2040.'

The Paris Agreement, which calls for governments to reduce their greenhouse emissions, will transform the future of the Japanese energy mix. The shortcomings around renewable energy operability indicate an inability to supply all energy needs. According to analysts Eclipse, Japan's total LNG demand is predicted to reach 77 MMt by 2020.

Japanese energy companies are continuing to invest in the LNG and gas aspects of their businesses. Mitsubishi recently commissioned the PT Dinggi Senoro LNG (DSLNG) project.



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## Expanding proven integral-gear technology into new applications

#### **TUSHAR PATEL, Atlas Copco Gas and Process**

*Gas Processing* welcomed the opportunity to discuss the gas and LNG industries with Tushar Patel, Marketing Manager of Atlas Copco Gas and Process.

#### *GP:* From an OEM perspective, how do you see the trends that are affecting the gas processing and gas transportation industry?

**Patel:** Several key trends have come into play and altered the over-



Tushar Patel, Marketing Manager of Atlas Copco Gas and Process

all picture in this sector. First, oil and gas prices are at a low level, largely due to high inventories. Due to this, the business landscape of the turbomachinery industry as a whole has been impacted. In particular, this historic downturn has affected OEMs that are active in gas processing, gas transportation and LNG. Conversely, some sectors, such as gas-turbine driven power generation, chemical/petrochemical and CNG, have benefitted from low-cost fuel. In this challenging environment, Atlas Copco Gas and Process sees opportunity and potential-we are expanding our core technologies to applications where they may not have been previously considered.

Our solutions—centrifugal compressors, positive displacement compressors and radial expansion turbines—are used primarily in industrial gases, hydrocarbon businesses and power generation. Like other active OEMs in the oil and gas industry, we were heavily affected by the market downturn, but this has helped us put greater focus on agility and address another key market trend we have witnessed: a strong end user focus on project lifecycle cost. This, in turn, has created a need for industry-standardized machinery. We are seeing increased activity for gas processing and gas transportation, and we predict that this upward trend will continue.

#### *GP:* Atlas Copco has been active in the LNG market for more than 40 yr. In your experience, how do new product developments compare to previous offerings?

**Patel:** We are committed to developing efficient solutions that consume less energy without compromising reliability and availability. Our recent technological milestones are designed for LNG liquefaction, LNG regasification or LNG transportation sectors, where we have been traditionally active. At the same time, we are looking to expand into new applications where we believe Atlas Copco's proven integral-gear technology would be a good fit.

Our primary goal is always to aim for the most energy-efficient compressor solution, with the smallest footprint, lowest installation cost and highest reliability. In many cases, the best solution for a specific application or process may actually be a highly customized and specified compressor. However, in an increasing number of scenarios, customers demand a more standardized, CAPEX-friendly compressor approach. We have seen many examples where such a leaner approach is both economically attractive and technically feasible. Our objective is to meet both of these general requirement scenarios.

### *GP:* Where does integral-gear technology fit into the LNG sector?

**Patel:** Any application in LNG or gas treatment plants requiring a compressor of 25 MW or smaller is a good candidate for employing integral-gear technology. Examples include compressors for boiloff gas, refrigeration, residue gas (**FIG. 1**), lean gas or companders for nitrogen used in smallscale LNG. For such applications, we are convinced that integral-gear technology has a sustainable future due to the reliability and efficiency it provides. Those are critical parameters in these sectors.

Integrally-geared centrifugal compressors have an advantage over other compression technologies because of their long maintenance cycles, reduced labor and maintenance costs, and the ability to replace redundant machines. When evaluating the best technological solution, positive displacement compressors are used in applications where the pressure ratio and flows are unsuitable for centrifugal technology. However, their comparatively higher maintenance increases total cost of ownership, making centrifugal technology worth considering wherever possible.

#### *GP:* What are your thoughts about bringing products such as mixed refrigerant compressors and nitrogen companders to the marketplace?

Patel: Small- to mid-scale LNG plants require operational flexibility, so integrally-geared, mixed-refrigerant compressors and companders are wellsuited for such applications. These type of plants require frequent startup and turndown, and high adjustability to fluctuations in feeding LNG through barges, railroads or trucks transporting LNG as a fuel. Integral-gear technology is flexible enough to meet these challenges, and this is where its benefits really come to fruition. With our first applications running for three to four years, we are receiving very positive feedback from key market players. In these discussions, we find that integral-gear technology is quickly building market reputation and acceptance as a reliable and efficient approach that is available at a very attractive CAPEX. To meet the Atlas Copco team, visit their exhibition stand 13-260.



FIG. 1. Integral-gear technology in gas processing: Atlas Copco's residue gas compressor.

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### Lowering costs along the entire value chain

In an exclusive interview conducted at Gastech, Gastech News had the pleasure of speaking with Patrick Pouyanné, Chairman and CEO of Total, to discuss the global energy mix and Total's forecast for LNG and natural gas demand.

#### Gastech News: What is the role of gas in the global energy sector? Are the combination of gas and renewables the way forward for a sustainable energy future?

**Pouyanné:** We are facing climate change challenges, and we are in a period of transition in terms of the evolving energy mix. Gas should play a brighter role and be the fossil fuel of the future, particularly in combination with renewables. Why? Because gas is very flexible and is a good combination to fulfill the intermittency of renewables. People want power, every day, every minute, so it is a question of reliability.

When you think of the future, the only fossil fuel we see with a longer growth is gas. However, we face some challenges. Renewables pose a challenge to gas, but coal will be the real challenge. You know the public: they want to arbitrate for affordable energy, so the question is, "Which will win, coal or gas?"

#### demand rising the fastest, and how is Total addressing these markets?

**Pouyanné:** Gas demand is growing mainly in emerging countries. Asia, Southeast Asia and the Middle East have a growing demand, as does South America. We must remember the direct link between gas price and demand—gas demand will only grow if the price is affordable.

At Total, we have been developing our operations in those regions for many years. We are among the top three in the LNG industry with supply sources in Qatar, Australia, Russia, Yemen, Oman and the Middle East. We have built up a sales portfolio that will reach 20 MMt by 2020. We have optimized the location between supply sources and customers, and we are a reliable supplier because we can guarantee that we will deliver the LNG to the customer. This is vitally important to our business.

#### Gastech News: Looking forward, what are the main growth opportunities for gas and LNG in a changing industry dynamic?

**Pouyanné:** Yes, changing industry dynamic is an issue. However, the volatility in this market must be faced to remain cost competitive. For us, when we select new LNG projects, we must consider that even if we have a wave of supply coming in front of us today, developing an LNG project takes approximately five years. So, what will supply and demand be like then? We need to think in terms of the costcompetitiveness of the various projects.

For example, we selected Papua New Guinea due to the large amount of onshore gas that is easy to develop, together with an existing plant with Exxon. We have also invested in Ob Bay's in Russia on Yamal LNG, which contains enormous resources of gas and offers very low upstream development costs. Of course, the Arctic environment presents numerous challenges, but we are developing it and the first train will come onstream before the end of the year. We are also targeting the US because the shale revolution is offering a large base of low-cost gas for decades. Developing LNG from US shale is another good opportunity for future development, and one of the key reasons that we invested in Tellurian.

#### Gastech News: How can major energy companies, such as Total, ensure future investment in major gas and LNG projects in the long term?

**Pouyanné:** First, we must work on the cost of the full chain, which means selecting the lowest-cost resources upstream and then working to lower the cost of the LNG plants. LNG plant costs have rocketed from less than \$500/t in 2000–2005, to \$1,500/t-\$2000/t. This makes gas expensive, and the customers pay the price.

We have set ambitious internal targets. Why can't we come back to something like \$500/t-\$700/t? Let's be aggressive. This means introducing technology. For example, smallscale LNG or modularizing the plants, looking to smaller trains rather than big trains. Technical innovations can be developed here.

The last part of the chain is the regasification of LNG, with new technologies such as FSRUs. Previously, an onshore terminal cost approximately \$800 MM to \$1 B. Now, you can bring LNG to a country like Ivory Coast, as we have done with Pakistan, for \$250 MM-\$300 MM. This is what we can do, work on the costs all along the chain.



Patrick Pouyanné, Chairman and CEO of Total.

#### Gastech News: Where does Total forecast LNG and natural gas

#### **EFFICIENCY**, continued from page 4

culture builds resilience, enhances efficiency and safety, and ensures greater stability."

#### Better project delivery through advanced technology.

Following Mr. Sano, and providing a contractor point of view, Alasdair Cathcart, President of Bechtel Oil, Gas & Chemicals, said that while his firm has "serviced the oil and gas sectors" for 80 of the company's 119-yr history, it continues to look for better ways to do things. Espousing a theme of "building efficiency through integration," Mr. Cathcart proudly noted, "Our tools can talk across the entire engineering procurement value chain."

On a second topic of "best-practice project delivery," Mr. Cathcart admitted, "It has become pretty obvious that just trying to focus on cost-competitiveness won't get us where we want to be." He explained that, in project delivery, "We have to implement everything that technology has to offer. We must take advantage of this." Mr. Cathcart was emphatic when he added, "I think it's also important that we find a way to eliminate 're-work.' We need to get away from bespoke (thinking) and try to use what the service industry has to offer. We need to think in terms of manufacturing, whereby equipment is standardized [to bring down costs]."

**Supply growth through improved market access.** Providing yet another unique perspective was Kees van Seventer, President for LNG at Dutch firm Vopak, the leading independent storage tank company. Mr. van Seventer chose to focus on growth through better access to markets. "Already, we are in 25 countries, with capacity of 20 Bcmy," said the executive. "Our global network of storage facilities is helping

us gain access to countries that are just

entering the LNG trade." Mr. van Seventer said that Vopak is well-positioned to make several investment decisions over the next 2 yr to drive growth. Furthermore, he said that the firm will improve profits by gaining additional productivity through "organizational and operational efficiency" that will help reduce Vopak's cost base. He also mentioned that Vopak will invest in new technology and innovation programs, as well as in replacing its IT systems. During the question-and-answer session, Mr. Cathcart delivered what may have been the most pragmatic comments of the morning. "In the EPC [sector], we have to be relentless in pursuing costs and business," he said. "Innovation is tough-we don't like things to break. I never thought I'd be sitting here, talking about how excited I am about the investments we are making in data analytics."

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### A global provider of natural gas analysis and metering solutions

Nicholas J. Clough, President and CSO of Orbital North America; and Richard Law, President of Orbital UK; spoke with *Gas Processing* to offer their perspectives on innovative gas solutions for the global industry.

#### *GP:* What changes/challenges are you personally witnessing in the gas industry, and how do you think they will play out in the future?

**Clough:** As a company that deals exclusively in natural gas, we have seen variations in the quality and condition of gas in pipelines due to the blending of imported gases. We see these changes in gas quality increasing over the coming years. Our technologies are tailored specifically to tackle these new challenges.

Law: As networks become larger and more complex with multiple



Nicholas J. Clough (left), President and CSO of Orbital North America, and Richard Law, President of Orbital UK.



**FIG. 1.** Orbital's GasPT<sup>®</sup> is an online analyzer that provides physical properties of natural gas.

JAPAN'S TEPCO, CHUBU TO MERGE FOSSIL FUEL

gas sources (LNG, shale or biogas) blending together into transmission systems, pipeline operators will also face the challenge of how to accurately bill the end user for the calorific value of the gas that was actually delivered. Another important challenge faced by the industry is the significant investment required to upgrade aging infrastructure.

### *GP:* What changes has Orbital experienced as a company over the last three years?

**Clough:** Orbital has traditionally been an integration company, supplying any number of technologies to the marketplace. While we still provide integration locally, we have grown into a global product provider. Our primary focus now is to deliver our unique technologies around the world.

Law: In our 30-yr history, Orbital has built a reputation in the UK of developing innovative solutions to complex problems in the field of natural gas analysis and metering. Our most recent focus has been to offer these solutions to a wider market and challenge traditional ways of thinking, to convince a reticent market that alternative methods exist.

### *GP:* Describe two or three innovative solutions developed by Orbital.

**Clough:** Our GasPT<sup>®</sup> (**FIG. 1**) device is the fastest, most efficient natural gas analyzer available on the market today. When paired with our VE Technolgy<sup>®</sup> sample system, it allows the user to achieve measured results from sample tip through to analysis in less than 10 seconds. IRIS is a remote telemetry unit (RTU) that empowers the user with real-time data and intelligence.

Law: GasPT truly represents an industry breakthrough in gas measurement. Together, Orbital's products and systems replace older technologies such as gas chromatography, issueprone sample probes and thermowells. Unlike traditional technologies, GasPT is capable of providing near real-time and continuous analysis, enhancing sampling frequency and removing uncertainty. It provides the lowest operational cost of any equivalent instrument.

#### *GP:* How have these products impacted the global gas industry?

**Clough:** GasPT, VE sampling technology and our IRIS RTU system are changing the way the industry can accurately meter and monitor their gas networks, bringing the whole industry up-to-date. Through the use of these systems, Orbital is able to offer the market the fastest and most accurate gas analysis capability in the world. In conjunction with our IRIS RTU system, we are able to offer the end user this data seamlessly and in a far more interactive way than has been possible before.

Law: Our equipment also has a far smaller footprint, removes the need for complex installations, is maintenance free and requires significantly less investment than traditional technologies. Adopters of the technology in the UK (National Grid) and in Italy (SNAM Rete Gas) are already seeing their CAPEX and OPEX costs reduced by adopting this technology.

### *GP:* What do you hope to achieve as a company by attending Gastech?

**Clough:** We are excited to be back in Japan, as Orbital has enjoyed strong working ties with the region in the past. We hope to use our presence as an exhibitor (12-250) to engage with some of the largest and most respected companies in the gas industry, and to challenge the status quo in relation to gas analysis, trace element detection and telemetry.

Law: Gastech 2017 is quite simply the place to be for the LNG industry. For a company like Orbital, we have a very important message to deliver to the industry: "There is a cheaper and more accurate alternative to traditional technologies."

#### **GP: What's next for Orbital?**

Clough: We will continue our work on improving the industry with our GasPT, VE Technology, IRIS-RTU technologies, and also growing awareness of our other offerings, BioMethane-To-Grid, Odorization and Integration. Law: Orbital will continue to educate the industry on the benefits of our innovative technologies, working towards wider market adoption around the world. As ever, we will continue to challenge the status quo and search for the next problem to solve. To learn more about how Orbital's products and technologies are changing the conversation in the process measurement industry, visit stand 12-250 and meet the Orbital team.

#### **POWER BUSINESSES**

Tokyo Electric Power Co. Holdings (Tepco) and Chubu Electric Power Co. signed an agreement to integrate their fossil fuel power plants under their JERA Co. joint venture.

The biggest and third-biggest of Japan's regional power utilities, respectively, aim to combine the businesses in April 2019 to September 2019 to form a company that will oversee 68 GW of capacity and account for nearly half the country's domestic power generation.

The agreement is the last of a three-step plan for JERA, which will oversee a global resource chain from

upstream investment, procurement and trading to power generation. In 2015, the two firms created JERA, which now handles all Tepco's and Chubu's upstream energy and fuel procurement business, and is the world's largest LNG buyer (approximately 40 MMtpy).

One of the sticking points for the integration of JERA was that Tepco was essentially nationalized after the Fukushima nuclear disaster in 2011. Tepco is to pay most of a \$194 B cost for compensation, decontamination and decommissioning, which raised worries that it would be unable to allocate necessary funds for JERA's growth plans. (Reuters)

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### Three 5-axis magnetic bearing controllers, one cabinet

#### **RICHARD SHULTZ, RICHARD JAYAWANT** and **ANDREA MASALA**, Waukesha Magnetic Bearings

On January 4, 2017, a new active magnetic bearing-supported motor compressor went into production use at a natural gas pumping station in Japan. The installation features the first use of a new magnetic bearing control cabinet with unique control electronics packaging. The single enclosure contains three 5-axis magnetic bearing controllers: one for the compressor bearings, one for the motor bearings, and one installed spare that can serve either the motor or compressor bearing system.

A system designed for custom tuning. The 3.3-MW centrifugal compressor and its high-speed electric motor are mounted in separate casings and connected by a flexible coupling, separating the dynamics of the two machines. The compressor is subjected to a wide operating range, with a design suction pressure of 38.5 bar-g, a discharge pressure of 79 bar-g, and a continuously variable speed ranging from 6,200 rpm to 9,400 rpm. By putting the compressor



FIG. 1. AMB control cabinet fitted with three Zephyr digital controllers.



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in a separate housing from the motor, machines with up to 18 MW of power compressor performance curves can be customized to match the required process conditions.

Both the compressor and the motor are supported on active magnetic bearings (AMBs). For the compressor, the system includes two radial AMBs and one axial, double-acting AMB, as well as radial and axial inductive position sensors, a speed sensor system and a set of hybrid auxiliary bearings. The motor bearing system includes two radial AMBs, radial inductive position sensors, a speed sensor system and a set of hybrid auxiliary bearings.

Requirements for high thermodynamic efficiency imposed tight radial clearances on the compressor's impellers and balance drum seals. Rotor modelling showed that a byproduct of these tight clearances would be dynamic cross-coupling and destabilizing effects at high speeds and high compression ratio. To handle the expected aerodynamic instabilities, a decentralized control architecture with dedicated and easily tunable low-frequency filter configurations was employed. Both the motor and compressor passed an extensive testing campaign and successfully met all API 617 and ISO 14839 performance requirements, with high margins on vibration levels and load capacity.

Robust, redundant control electronics. The motor and compressor AMB systems each have a digital controller designed to handle

in a 90 cm × 33 cm × 50 cm package. Like larger digital AMB controllers, the compact Zephyr controller provides 5-axis control and high processing performance for complex algorithms.

The motor and compressor AMB controllers were installed in a single control cabinet, along with a spare and associated power supplies and cable marshaling (FIG. 1). Minimal actions are required to align the third, spare controller to either the motor or compressor bearing system, in the rare case that the spare is required. The installed spare maximizes availability of the motor compressor string and minimizes the mean time to repair (MTTR).

The controller capabilities include automation of many of the routine functions performed during AMB commissioning, including verifying the integrity of the machine build, clearances and associated field cabling; sensor configuration and calibration; configuration and tuning of amplifier servo loops; and configuration and tuning of position servo loops. Automated commissioning tools, combined with remote monitoring and tuning capabilities through a web services interface, were applied to reduce commissioning time and the required presence of the commissioning engineer onsite.

The motor compressor has performed flawlessly to date, and the unique magnetic bearing control cabinet ensures minimum disruption of operability in the unlikely event a problem occurs.

#### **EVOLVING GAS LIQUEFACTION** AND ASSOCIATED INFRASTRUCTURE

As trends in energy production and use evolve, so too must plans for networks to produce and consume that energy. In no subsector is this more apparent than gas liquefaction and its associated infrastructure-particularly in the US.

In February 2016, Cheniere Energy's Sabine Pass LNG terminal in Cameron Parish, Louisiana became the first project in the US to export LNG from domestic shale gas. The terminal, inaugurated in April 2008, was originally designed to import LNG to supplement dwindling domestic gas supply. Then the shale boom hit, and the US suddenly found itself sitting atop vast reserves of shale oil and gas. In 2010, Cheniere became the first company to apply for a permit from the US DOE to export LNG to countries that do not have free-trade agreements with the US. Several other companies have followed suit. More applications have been received for domestic LNG export projects than will be approved or built. Cheniere itself is adding more LNG trains to Sabine Pass, and building another LNG export terminal at Corpus Christi, Texas. To support the ongoing operations and train additions at Sabine Pass, Kinder Morgan applied in December for authorization to add bidirectional capacity on its Louisiana pipeline. The \$151-MM project would send gas to the terminal from 2019, when a fifth train is anticipated to come online. The pipeline was originally put into service in 2009 to send regasified LNG from Sabine Pass to US markets; however, the shale boom eliminated that need. Similar alterations to planned and in-service infrastructure are predicted over the next several years as more LNG export projects come online in the US.

a timely gathering for the gas processing industry to discuss the latest challenges and developments; learn about the current economic outlook; share best practices; explore solutions to help improve production and efficiency and network with peers.

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### Thailand welcomes Future Energy Asia 2018 at Gastech press event

#### ADRIENNE BLUME, Gas Processing

A press conference on Wednesday announced the Future Energy Asia industry gathering in Thailand in 2018. The press event was hosted by the Thailand Ministry of Energy and the Thailand Convention and Exhibition Bureau (TCEB), in partnership with the organizers of Gastech and ADIPEC.

Speakers included Christopher Hudson, President of Energy for dmg :: events; Areepong Bhoochaoom, Permanent Secretary of the Ministry of Energy of Thailand; and Jaruwan Suwannasat, Director of Exhibition and Events for the TCEB.

Mr. Hudson welcomed media attendees and noted that Thailand will serve as a global meeting point for the developing energy industry in Asia. "This event will not only service the growing population of Thailand, but all of Asia," he said.

**Thailand looks to become Asian energy hub.** Mr. Bhoocha-oom discussed the Thai government's priority to develop business opportunities for both integrated and non-integrated energy companies in Asia and around the world. "Energy is the most important factor at the heart of Asian people," he said. "We have 4.4 B consumers—60% of the world's population. We need to utilize existing hydrocarbon resources while embracing new energy supplies."

Mr. Bhoocha-oom touted Future Energy Asia as an ideal platform for NOCs and IOCs to encourage the transition from traditional fuel suppliers to integrated energy providers. "Future Energy Asia is the first step in establishing a leading annual platform for the oil, gas and renewable energy sectors—in an integrated way. This will create balance among energy security, prosperity and sustainability for Thailand and for Asia," he said.

The minister also named the five pillars of Thailand's "Energy 4.0" plan. These goals will require significant infrastructure development and technology innovation. The pillars include:

- A 20-yr electrical power development plan
- An energy-efficiency plan to obtain more energy from in-place infrastructure and resources
- A renewable/alternative energy plan, with a target of 30% renewable energy content in Thailand's energy mix in 20 yr
   An ail supply plan to import
- An oil supply plan to import

more than 80% of Thailand's oil requirement

• A natural gas supply plan that will require the import of additional LNG.

**Thailand's need for more LNG.** "Thailand's gas will deplete in the future, so we already have a plan to build four more LNG terminals to prepare for the reduction of Thailand's [domestic] gas and to receive gas from the rest of the world," Mr. Bhoochaoom said. Almost 70% of Thailand's electricity is fueled by natural gas, but the country's reserves have been dwindling over the past 5 yr.

To this end, the minister named as primary energy initiatives a "focus on electrical vehicles, charging stations, gas storage, micro-grids and smart cities—all things that will make Thailand more energy-efficient and ecofriendly," he said.

#### See you in Thailand in 2018!

Ms. Suwannasat of TCEB spoke about Future Energy Asia's debut in Thailand, noting that the country welcomed more than 1.2 MM visitors in 2016 for business events. Thailand is easy for Asian visitors to reach, both in terms of location and visa requirements. It also boasts a variety of tourist destinations and resort locations for visitors to enjoy around their business stay. "I hope to see all of you at Future Energy Asia in 2018," Ms. Suwannasat said.

**Future Energy Asia** will be held at Thailand's Bangkok International Trade and Exhibition Center (BITEC) from 12–14 December 2018. It is expected to draw 15,000 visitors, 2,500 delegates, 300 speakers and 600 exhibitors.



Thailand, a future Asian energy hub, will host Future Energy Asia in 2018.

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### **Developments with ZR-LNG liquefaction**

#### BILL HOWE, Gasconsult Ltd.

The fall in oil prices and the knockon impact on LNG prices have cast doubts over the viability of many planned LNG facilities. New solutions are required to create financially sound projects. London-based technology licensor Gasconsult has developed innovative liquefaction cycle concepts to address these issues. Many of these concepts are particularly compatible with FLNG, where special design considerations apply: a need for compact layouts, lower weight and smaller footprint to minimize the size and cost of the host hull, while maximizing LNG production through a high liquefaction cycle efficiency.

The use of methane refrigerant as an alternative to the use of nitrogen or mixed hydrocarbons has been the focus of Gasconsult's developments.



**FIG. 1.** Gasconsult's ZR-LNG process, which comprises only two compressor packages and eight major equipment items, is simple and similar in concept to nitrogen expander processes.

The company's patented ZR-LNG process uses methane-rich feed gas as the refrigerant medium in an optimized system of expanders. Compared to mixed refrigerant cycles, this process eliminates refrigerant storage and transfer systems, as well as the process equipment used to extract refrigerant components from the feed gas. By eliminating liquid hydrocarbon refrigerants, the operating environment is made safer, particularly for FLNG, where escape routes are limited in the event of fire or explosion.

**Basic configuration.** The ZR-LNG process is simple and similar in concept to nitrogen expander processes. It comprises only two compressor packages and eight major equipment items. A simplified schematic of

the process is shown in **FIG. 1.** Power demand in temperate climates is approximately 280 kWh/t (kilowatt hours per tonne) of LNG, which is close to dual-mixed refrigerant processes and equivalent or lower than the single-mixed refrigerant schemes. ZR-LNG produces approximately 40% more LNG than the dual expander nitrogen process from the same compressor driver.

The ZR-LNG advantage over nitrogen cycles stems from two factors. Methane has a higher specific

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heat than nitrogen. This significantly reduces circulating gas flows which, in turn, reduces power consumption and pipe sizes. Secondly, ZR-LNG performs a partial liquefaction in its low-temperature expander CX2. This efficiently converts latent heat directly into mechanical work, and permits a reduction in heat transfer area and cost of the main heat exchanger HX1.

#### Alternative configurations. To

meet today's industry needs, Gasconsult has developed alternative configurations for ZR-LNG with the potential for significant CAPEX reduction. These configurations also have excellent compatibility with FLNG:

- Integrated heavies removal (IHR). Where the feed gas is above or close to its critical pressure, configuring ZR-LNG to utilize its existing warm expander obviates the need for a separate expander-based NGL recovery system to achieve vapor/liquid separation, saving cost, space and weight.
- Integrated CO<sub>2</sub> removal (ICR). Within the ZR-LNG configuration, ICR can eliminate the need for an upstream amine unit, saving cost, space and weight. ICR is facilitated by the particular temperature and CO<sub>2</sub> concentration profiles within the ZR-LNG cryogenic exchanger, allowing CO<sub>2</sub> removal post-liquefaction by solid/liquid separation. ICR is applicable to feed gases containing up to 5% CO<sub>2</sub>.
- High-speed compression (HSC). Using methane as the refrigerant medium allows much higher compressor rotating speeds than are possible with mixed refrigerants or nitrogen. This allows the use of smaller, lower weight and lower cost compressors. Compressor speeds up to 10,000 rpm are envisaged, producing compressor/gas turbine cost savings of 20%, in addition to space and weight reductions.
- Integrated pressure liquefaction (IPL). For lowpressure feed gases, the main ZR-LNG recycle compressor

**Technology advantages.** In addition to its simplicity and low power demand, various advantages have been identified for ZR-LNG during discussions with industry experts. Many of these advantages have particular relevance for FLNG schemes, where weight, deck space, operational simplicity and safety are important factors:

- Refrigerant storage, extraction and transfer facilities are eliminated, reducing capital cost and footprint. For FLNG, the freed up deck space can be used to install additional productive liquefaction capacity, further enhancing project returns.
- Refrigerant logistics issues in remote or offshore locations are eliminated. Shipments of light and heavy hydrocarbons, and segregated storage to facilitate the blending of a mixed refrigerant are not required.
- Lean feed gases are readily handled, as external refrigerants do not need to be imported.
- Absolute security of refrigerant supply is ensured.
- Propane or other liquid hydrocarbon refrigerants are not required, a major safety advantage relative to mixed refrigerant schemes, particularly for FLNG.
- The system is motion tolerant, as the refrigerant is single-phase (always a gas), another positive for FLNG schemes.
- Other than the feed natural gas, refrigerant make-up costs are not needed to replace losses from plant upsets and/or seal losses.
- Refrigerant composition adjustments are not required to maintain cycle efficiency.
- Relative to mixed refrigerant processes, a shorter startup from warm can be expected.
- Flaring is reduced relative to mixed refrigerant processes.

For mid-scale and FLNG operations, the ZR-LNG process is well positioned for today's low energy price era. A fundamental simplicity and low equipment count achieve a very attractive power demand. Unlike some proprietary liquefaction processes, equipment supply is not tied to the technology licence, and all equipment is available from multiple vendors. Importantly, in this financially challenging era, this allows for fully competitive procurement with project cost and schedule benefits.



can be utilized to boost feed gas pressure and increase liquefaction cycle efficiency, without the need for a separate feed gas compressor station.

#### **GASTECH MOVES WEST FOR 2018**

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**12** Friday, 7 April 2017

# The time is NOW for real-time monitoring of ICS/OT networks

#### DAVE DEWALT, Claroty

I have spent the better part of the last two decades working in the cybersecurity market. Over that time, I witnessed some incredible threats, breaches and events, including the dawning of the Chinese military threat that affected thousands of organizations from 2008– 2015, sophisticated criminal hacks in the retail industry, the brazen shutdown of Sony by North Korea, and recent Russian actor activity in America's election process.

The writing is on the wall for an unfortunate next phase—attacks on industrial networks are coming, as evidenced by the continued probing of US critical infrastructure and recent attacks on the Ukrainian power grid.

With all that we have seen, this latest development is the most alarming. The attacks that we once spoke of as theoretical and that we thought represented a "red-line" that was too solid for anyone to cross, are becoming a reality. Industrial networks are now a target of our adversaries, and not just nation-state actors. We are already seeing cyber criminals attack these networks with ransomware. What we must understand is that industrial networks are everywhere: in oil and gas, chemical, transportation, manufacturing, and even building and data center management systems. These networks power our industries and underpin our global financial system.

In the oil and gas industry specifically, these networks are so critical to production and important to safety that disruption of any significance could literally cost lives and untold sums of money, and cause major turmoil around the globe. In my mind, the challenge of our times as security professionals is to protect these networks from the coming storm.

We are witnessing the rapid digital transformation of industrial control system (ICS) networks, which presents the introduction of major safety and security challenges. While traditional security companies paid lip service to ICS security, it has taken a back seat to other disciplines. With unprecedented and rapidly increasing risk, change must be immediate, and the market favors the bold. I have been following these dynamics closely, and Claroty is the company that stood out as the one to lead this revolution.

For these reasons, I've chosen to join Claroty as Chairman of the Board. Claroty was founded in Tel Aviv,

Israel by some brilliant minds, includ-

ing founders who served on the front lines, within elite cyber units of the Israeli Defense Force. The company has created a world-class, real-time monitoring and alerting platform that safely and securely protects critical infrastructure. They have analyzed dozens of ICS protocols, and then create a fine-grain model of a customer's ICS network and employ sophisticated algorithms to detect anomalous and other high-risk activities that can harm industrial processes.

I look forward to working with the devoted team at Claroty for many years to come. We are on a mission to protect the most important networks in the world—most notably, yours.



DAVE DEWALT is the Chairman of the Board at Claroty, and most recently served as Executive Chairman and CEO at FireEye. In addition to his deep security industry expertise,

his role as Vice Chair of Safety and Security on the Delta Airlines Board of Directors provides him with an intimate understanding of the issues confronting OT network operators across nearly every major industry.

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"The natural gas supply has become more variable with the inclusion of fracked and biogas components, resulting in significant deactivation of emissions control catalyst systems," said Ying Wu, General Manager of Clean Air for BASF. "Oxidation catalysts have shown to deactivate very quickly in the presence of sulfur. Therefore, we developed, tested and are now launching Camet ST sulfur tolerant catalyst to handle very high levels of sulfur with minimal deactivation."

In extended full-scale trials, BASF Camet ST sulfur tolerant catalyst maintains performance. Camet ST is deployed in several commercial units where sulfur contamination previously resulted in excessive downtime and frequent cleaning.

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### **Tracking 2016 Eastern Asian LNG imports**

#### ADRIEN MARTINEZ-MÉRÉ, CEDIGAZ

LNG imports in Japan, South Korea, China and Taiwan reached a total of 157.9 MMt (millions of tons) in 2016, increasing by 3.4% compared to 2015 (152.7 MMt). This growth came mainly from China—where imports surged by 33% year-on-year—and, to a lesser extent, from Taiwan (+2.7%). Imports for the world's two largest consumers of LNG, Japan and South Korea, changed by -2% and +0.2%, respectively (**FIG. 1**).

**Japan.** Contributing to approximately one-third of global LNG demand, Japan is the world's largest importer of chilled gas. In 2016, the country imported 83.3 MMt, down by 2% from the previous year (85 MMt). 2016 was the second consecutive year that Japanese imports decreased.

Specifically, LNG imports decreased by 5.3% during the first half of 2016, before rising by 1.4% in the second half of the year. Despite a 2.7% growth of sales in 2016, pulled by a higher gas demand in the industry, several other factors had a negative impact on LNG imports. Electric power demand decreased by 1.4% to 885.6 TWh (terawatt hours). LNG demand by the power sector was further curtailed by the growth in nuclear and renewable energy outputs (+292% and +58.7%, respectively). The two 890-MW Kyushu nuclear reactors were restarted in September 2015 and November 2015, and remained operational during most of 2016 (before being shut down for maintenance from October 2016), while the 890-MW Shikoku nuclear reactor resumed commercial operations in September 2016. As a result, the electricity generated by nuclear plants in 2016 was almost four times higher than in 2015.

**South Korea.** LNG gross imports in South Korea rose slightly (+0.2%) in 2016 to 33.5 MMt, ending a twoyear period of decline. The country chose to reduce its dependence on imported fuels by increasing nuclear capacity in the power sector. Nuclear output increased by 5.7% from 1Q to 3Q, while LNG deliveries slumped by 5.8% over the same period.

However, following an earthquake in early September 2016, several nuclear plants were shut down for safety assessments. This, combined with lower than average winter temperatures that drove heating demand, led to a 15.7% jump in LNG imports in 4Q.

**China.** The country recorded the world's most significant rise in LNG imports in 2016. Purchases reached





26.2 MMt, an increase of 33%. China's chilled gas imports ramped up throughout the year, growing by 17.4% in 1Q, 25.7% in 2Q, 38% in 3Q and 49% in 4Q. This was due, in large part, to the sharp rise in deliveries from Australia as the first train of the Australia Pacific LNG (APLNG) terminal came online in January 2016, and the 7.6-MMtpy supply contract with Sinopec began. As a result, Australia overtook Qatar to become the largest LNG supplier to China (46% of total imports).

According to provisional official data, gas consumption grew by 6.6% in 2016, to 205.8 Bm<sup>3</sup>, while domestic gas production rose by 1.5% to 137.1 Bm<sup>3</sup>. Pipeline imports jumped by 13.3% to 38 Bm<sup>3</sup>, according to customs data, after a 7.2% increase in 2015.

**Taiwan.** Taiwan imported a total of 15 MMt of LNG in 2016, up by 2.7% year-on-year. CPC, Taiwan's sole LNG importer, benefited from term contracts signed with Malaysia, Papua New Guinea, Indonesia and Qatar. It also took more deliveries from Russia, which became the country's fifth largest supplier (8.5% of total imports).

Energy demand rose by 1.8%, supported by every sector. Chilled gas was the fastest growing fossil fuel (+4.2%), followed by petroleum products (+2.2%). Coal declined by 0.6%, and Taiwan's nuclear output dropped for the second consecutive year (-14% in 2015, and -13.2% in 2016).

#### The fall of average LNG import

**prices.** As a consequence of the continuing drop in oil prices, average LNG import prices in Eastern Asia fell for the second consecutive year (**FIG. 2**), from \$9.5/MMBtu in 2015 to \$6.7/ MMBtu in 2016. Much of the drop occurred in 2Q, with LNG prices rising again in the second half of the year.

Average LNG import prices of the four Eastern Asian importers continued to converge throughout 2016. In January, the spread between the minimum (\$7.1/MMBtu in Taiwan) and maximum (\$8.0/MMBtu in South Korea) average import price was \$1.0/ MMBtu, down from \$4.6/MMBtu one year before. In December, this spread was reduced to just \$0.3/MMBtu (\$7.0/ MMBtu in Taiwan, and \$7.3/MMBtu in South Korea).

Spot LNG prices in Japan averaged \$5.6/MMBtu in 2016, down by \$2.0/ MMBtu from 2015. As Japan reduced its imports, prices declined from January to April to reach \$4.0/MMBtu, the lowest level in years. Prices then began to rise again, reaching \$5.4/MMBtu in 3Q and \$7.4/MMBtu in 4Q.

Australia: Eastern Asia's biggest supplier in 2016. Numerous projects in Australia came online in 2016, including Gorgon LNG (Trains 1 and 2), APLNG (Trains 1 and 2) and Gladstone LNG (Train 2). As a result, Australian deliveries to Eastern Asian countries soared by 13.3 MMt, well above the second biggest increase, which came from Indonesia (+1.1 MMt). Meanwhile, imports from Qatar dropped by 3.6 MMt, driven by the collapse of deliveries to Japan (-2.5 MMt), Taiwan (-0.7 MMt) and South Korea (-0.5 MMt). Supplies from Nigeria and Yemen also decreased significantly (-3.1 MMt and -1 MMt, respectively).

Amid those changes, two countries returned to the Eastern Asia's LNG market: Egypt, which temporarily restarted operations and exported two cargos (to Japan and China); and Angola, which restarted its production after different stages of maintenance due to a pipeline rupture in 2014 (one vessel to South Korea).

Finally, with a market share of 25.1%, Australia overtook Qatar (22.4%) to become Eastern Asia's biggest supplier in 2016—only one year after taking Malaysia's second position.

With 59.4% of total deliveries, Asia-Pacific increased its share by 7.2 points compared to 2015 (**FIG. 3**), whereas the Middle East and Africa's market shares decreased by 4 points (to 29.9%) and by 3.2 points (to 2.8%) respectively. Finally, deliveries from Europe remained flat (+0.1 point).



**FIG. 2.** Eastern Asia LNG prices, January 2013–October 2016. Source: Cedigaz LNG Service. Spot price based on Reuters estimates.

FIG. 3. Origin of imports in Eastern Asia. Source: Cedigaz LNG Service.

14 Friday, 7 April 2017

### **Scenes from Gastech**

















- Kerry Anne Shanks, VP of Gas & LNG at Wood Mackenzie, provided a detailed preview of next year's Gastech Exhibition & Conference, which will be held in Barcelona, Spain, 17–20 September 2018.
- 2 Japanese manufacturer of pressure safety valves, Fukui, showcased a Lego model of its product.
- **3** Wednesday evening, Mitsubishi Corporation created an oasis of calm serenity, as one of their team performed a traditional Japanese tea ceremony.
- The team from Dow took a short break from highlighting their products 4 and capabilities.
- 5 Wednesday evening in the stylish Tellurian booth, two energetic taiko drummers thrilled a capacity crowd.
- 6 Atlas Copco Gas and Process' stand was consistently busy with colleagues and potential clients.
- We extend our gratitude to the friendly and capable Makuhari Messe staff 7 and the dmg :: events team for another well-organized and successful Gastech Exhibition & Conference.
- The open and spacious Wartsila exhibit provided the perfect setting 8 for serious discussion and networking.

The Official Gastech Show Daily Exhibition & Conference Newspaper **DAY FOUR** 



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