About This Report

The position of natural gas in the global power market has never been higher. So why all the uncertainty?

As natural gas broadens its footprint around the globe amid the continued migration away from coal and the adoption of greener energy options, the 2019 Strategic Directions: Natural Gas Report takes a deep look at the complexities and market dynamics across the value chain.

Growing population centers, emerging production leaders and trade relations are influencing gas production and transport. Liquefied natural gas (LNG) and liquefaction capacity, for example, are dramatically altering the volume of supply available to global markets, with investment in floating LNG escalating as developers see opportunity. But more build-out of infrastructure will be required to bolster LNG trade, most notably in densely populated Asian regions, where coal rapidly gives way to natural gas as a cleaner-burning preference that adheres to some countries’ environmental goals.

The industry’s challenges are diverse, from the wider embrace of renewable energy growing cheaper and more mature by the day to the preference for short-term natural gas contracts that give buyers more sway in bargaining. Geopolitics also are in play, as are trade challenges involving China, which is broadly considered on the cusp of becoming the world’s biggest natural gas importer.

The 2019 Strategic Directions: Natural Gas Report explores these dynamics and how upstream, midstream and downstream enterprises are managing operations. Regardless of their roles in the supply chain or geographic location, organizations are adapting to the global forces shaping the natural gas industry.

We welcome your questions and comments regarding this report and/or Black & Veatch services. You can reach us at MediaInfo@bv.com.

Sincerely,

HOE WAI CHEONG  |  President, Black & Veatch’s oil & gas business
JOHN CHEVRETTE  |  President, Black & Veatch Management Consulting
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Reflecting an unmistakable optimism about the role of natural gas and its emerging markets, the U.S. Department of Energy’s Steven Winberg pressed a certain benevolence about America’s unstoppable emergence as a global leader in gas production. “Every molecule of energy that the United States exports is exporting freedom to the world,” the assistant secretary for fossil energy said during a Senate committee in September 2018.

Winberg’s enthusiasm about rising overseas demand for America’s homegrown hydrocarbons may be justified, given a myriad of metrics that include countries and continents turning away from coal and leaning heavily into greener energy to cut their carbon footprints. But potential challenges abound, not the least of which is whether geopolitical forces may dampen the United States’ hard-charging marketing of the fossil fuel.

The situation is rife with complexities and disparate pressures, as are so many things in the arena of natural gas. In this year’s 2019 Strategic Directions: Natural Gas Report, we explore the sector’s weightiest topics and offer insights driven by survey input from hundreds in the industry and our decades of experience serving the natural gas marketplace.
Opportunities in Liquefied Natural Gas: The United States is ready to assume the mantle of global leader in providing liquefied natural gas (LNG) to the world. According to the International Energy Agency (IEA), the U.S. accounts for nearly 45 percent of growth in global production and nearly three-quarters of LNG export growth. At least for now, these are optimistic and opportunistic times for LNG despite potential headwinds that include the widening adoption of renewable energy.

Capitalizing on Floating LNG: Over the past few years, we've watched closely as the floating LNG (FLNG) industry shifted from potential to actualization. Early adopters of this inventive strategy sought means to move supply to end users quickly, efficiently and economically; the 2018 key milestones of Golar LNG’s Hilli Episeyo and Shell’s Prelude FLNG vessels have opened the eyes — and wallets — of new developers.

Trends in Gas-to-Power: U.S. producers are investing heavily in liquefaction. This, paired with strong international interest in converting from oil-based power generation to gas-based, sets the stage for the U.S. to dominate the world market. Several major trends will shape gas-to-power going forward.

Renewables and Natural Gas: Renewable energy sources have become the elephant in the room when it comes to natural gas markets. As their prices drop and capabilities expand and mature, power derived from solar, wind and other distributed energy technologies are taking an increasingly high position in the global discussion around power generation.

Can Pipeline Capacity Keep Up: As if the persistent low-price environment weren’t enough, rampant natural gas production in the hotbed Appalachian and Permian Basins is ramping up concern that pipeline capacity can’t keep up. This comes as the U.S. natural gas industry prepares to enter one of its strongest growth periods to date.

Growth in Asian Demand: Strong economic growth, low gas prices and environmental goals involving broader adoption of green energy as an alternative to coal-fired power are transforming natural gas demand in Southeast Asia. Now, appropriate infrastructure is essential to facilitate the deployment and support of gas.
Without question, natural gas is enjoying its star turn in America. As of 2017, the United States was an annual net natural gas exporter for the first time in nearly six decades. The country has added to that in 2018, more than doubling its average daily net exports for the first half of the year over 2017, the U.S. Energy Information Administration (EIA) says.

In 2018, U.S. relations with at least two of the world’s biggest players in natural gas were uneasy. Russia, with its ever-expanding stretch of pipelines, is entrenched as the European Union’s biggest supplier of natural gas while that region slowly weans itself off of coal, crimping U.S. efforts to move into that market.

In what broadly has been cast as a U.S.-Russia “gas war,” Winberg told a Senate panel recently that Europe’s growing dependence on Russian gas doesn’t have to be, given that “our nation is endowed with the vast supplies of natural gas, and production is growing rapidly.” And, as of October 2018, the U.S. was in a trade dispute with China, which the IEA expects to become the world’s biggest natural gas importer next year. Effects of the dispute range from the potential disruption to future LNG infrastructure investments to a squeezing of potential U.S. supply to the world’s most populous country.

All of these matters are part of the mosaic that puts natural gas at a crossroads, given competing and rapidly evolving forces involving the growing supply of natural gas from new producers and the falling costs of renewables.

There’s a broader embrace of renewable energy and the preference for shorter-term contracts, giving natural gas buyers the upper hand in bargaining amid the disparity in the supply and demand.

The federal government predicts that domestic gas production will spike by 22 billion cubic feet per day (Bcf/d) to 103 Bcf/d by 2029. The build-out of export terminals from which natural gas is liquefied for stable tanker shipment continues in the U.S. as overseas markets bring more floating storage and regasification units online.

That growth comes against the backdrop of diverse pressures. There’s a broader embrace of renewable energy and the preference for shorter-term contracts, giving natural gas buyers the upper hand in bargaining amid the disparity in the supply and demand.

And there’s the potential thornier headwind of geopolitics that could complicate the current presidential administration’s quest for what it has called “American energy dominance” through LNG exports.

Forty countries now import natural gas, up 11 in just the past five years.

Two years since the U.S. first started shipping off its wealth of natural gas from hydraulic fracturing production and shale field discoveries, its LNG has reached dozens of foreign destinations on at least four continents. Forty countries now import natural gas, up 11 in just the past five years.
Broadening that American influence appears top of mind among domestic players in that industry. Eighty-two percent of industry respondents to Black & Veatch’s survey said that U.S. emergence as a major LNG supplier either was extremely likely to somewhat likely to shape the global market over the next half decade (Figure 1). That was closely followed by increased spot market transactions and emergence of new LNG markets in developing countries.

Separately, roughly 57 percent of respondents said they expect India to be a leader in boosting its LNG imports from the United States. More than 40 percent listed Japan, China and the European Union as expected to do the same. Australia and Africa continue to play increasing roles in the global market; Australia is positioned to become the world’s biggest LNG exporter, while Africa looks to capitalize on its reserves, some newly discovered.

All the while, geopolitical forces stand to pull at the market, largely in the form of public policy goals calling for wider adoption of renewables. California intends to get all of its energy from renewables by 2045, while Europe and Africa have set their renewables milestone at more than 20 percent. China is diversifying its clean energy portfolio, shipping in more natural gas and adopting energy-efficiency policies amid its pullback on coal-fired power generation that has some of its regions enveloped in an ambient haze.

Considering this and other geopolitical scenarios yet to surface, the demand for nimble, agile and forward-thinking leadership comes to the fore as the industry keeps a close eye on global trends and strategically maps out business opportunities.

**FIGURE 1**

To what extent are the following emerging trends likely to shape the global LNG market over the next five years?

<table>
<thead>
<tr>
<th>Emerging Trend</th>
<th>Extremely Likely</th>
<th>Somewhat Likely</th>
<th>Neither Likely nor Unlikely</th>
<th>Unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>The U.S. emerging as a major LNG supplier</td>
<td>41.7%</td>
<td>40.3%</td>
<td>8.3%</td>
<td>9.7%</td>
</tr>
<tr>
<td>Increased spot market transactions</td>
<td>35.2%</td>
<td>45.7%</td>
<td>16.9%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Emergence of new markets for LNG in developing countries</td>
<td>43.7%</td>
<td>32.4%</td>
<td>18.3%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Supply/demand imbalance</td>
<td>32.9%</td>
<td>42.9%</td>
<td>15.7%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Lowering of LNG project costs</td>
<td>24.3%</td>
<td>47.1%</td>
<td>18.6%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Renegotiation of traditional contractual terms</td>
<td>19.7%</td>
<td>50.7%</td>
<td>25.4%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Emergence and prevalence of smaller scale LNG including FLNG</td>
<td>23.2%</td>
<td>39.1%</td>
<td>31.9%</td>
<td>5.8%</td>
</tr>
<tr>
<td>LNG for transportation (bunkering, road, rail)</td>
<td>22.5%</td>
<td>39.4%</td>
<td>23.9%</td>
<td>14.1%</td>
</tr>
<tr>
<td>Asian buyers converging to create buyer consortiums</td>
<td>19.1%</td>
<td>42.6%</td>
<td>30.9%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Emergence of Asian price index</td>
<td>18.6%</td>
<td>34.3%</td>
<td>35.7%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
Increasing global gas supply from newer producers like the United States, demand growth from developing economies in Asia, policy choices supporting cleaner energy sources the world over, lowered costs of renewables, and significant geopolitical shifts are reshaping the global natural gas market.

But the rise of renewables holds a special footing in this conversation. Renewable energy sources are the darling of the global discussion around sustainable power generation. As their prices drop and capabilities mature, solar, wind and other distributed energy technologies are taking an increasingly prominent position in the energy mix and creating new dynamics for stakeholders to consider. At a recent conference of oil and gas industry participants in Spain, we posed three blunt questions:

- **Is natural gas the bridge to our energy future** — a cleaner-energy connection that helps move us from fossil-based generation sources to a future of global energy primarily sourced from renewables?

- **Is it the destination** — an acknowledgement that natural gas is here to stay, given its extended low-price cycle, abundancy, mature supply chains and ability to complement a renewables strategy?

- **Or is it a has-been** — a solution whose need has been surpassed by the increasingly robust tool sets of renewable energy resources?
We can say with some certainty that the “has-been” label is too strong and vastly understates natural gas’ current global importance. Natural gas is attractive to developing economies and emerging markets in ways that renewables cannot currently match, particularly in price and potential access to supply. Competing factors make answers to those questions less than absolute, however, and what is clear is that the long-term dominance of natural gas is in question and bears watching by stakeholders.

**An Approaching Solar Storm?**

Growing concern among industry players is unmistakable. Respondents to Black & Veatch's 2019 Strategic Directions: Natural Gas Report survey appear more bullish on the near-term growth potential than the long term. While optimism is dominant in both windows, neutral and pessimistic outlooks arise the further respondents look into the horizon (Figure 2).

Clean energy-driven public policy goals across the world, combined with perceptions of falling renewable and energy storage costs, present a displacement scenario for natural gas. A major factor is government-driven sustainability mandates. Africa, Europe and India have all set aggressive renewable energy targets by 2030. In China, where air quality concerns are driving power generation away from fossil fuel sources, the government is pursuing wider adoption of renewables, although its near-term roadmap relies significantly on LNG imports to create distance from coal.

Within the U.S., the “has-been” argument is strongest in California, which recently passed policies requiring renewables to account for 60 percent of power generation by 2026, and 100 percent by 2045. Renewable sources already served 50 percent of California’s total electric load in 2017, and in some scenarios, solar photovoltaic (PV) has already begun displacing midday natural gas generation.

Meanwhile, there is a sustained trend of declining renewables and storage costs. According to Bloomberg New Energy Finance, global solar capacity is expected to reach 740 gigawatts by 2022, with nearly half of installed capacity and a third of electric generation coming from wind and solar sources by 2040. Energy storage, the key to fully harnessing intermittent power generation, will continue to gain momentum and catalyze the growth of renewables.

Natural gas, however, is anything but diminished on the global stage. Key factors will both keep natural gas as a global energy centerpiece for the foreseeable future but also shift the market and stoke lingering questions about long-term investment (Figure 3).
**FIGURE 3**

Destination markets in China, India, Southeast Asia and Africa

**CHINA**
- Air quality concerns drive push away from coal
- World’s largest renewables capacity
- Second-largest LNG importer ahead of South Korea

**SOUTHEAST ASIA**
- Southeast Asia benefits from technological advances including FSRU
- Indonesia, Malaysia, Singapore, Bangladesh, Philippines all represent relatively new markets for natural gas

**INDIA**
- India adopts a less aggressive attitude towards coal; availability and cost are important local factors
- Growing renewables capacity
- Gas demand triples, driven by industrial needs

**AFRICA**
- Africa’s per-capita energy needs lag behind other developing economies
- Significant institutional challenges remain to natural gas development
- Africa can present significant growth opportunity with higher productivity

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**Demand in Emerging Markets:** The IEA forecasted in its Southeast Asia Energy Outlook 2017 that demand for natural gas will grow by 60 percent by 2040, due to rising consumption in power generation and industry. One estimate holds that by 2035, more than half of the region’s gas demand will be met by LNG. Demand growth for natural gas from India and China, despite each country’s renewable energy targets, reflects an “all of the above” approach to meeting energy demand that should keep natural gas in the discussion far longer than many anticipate.

**LNG Infrastructure is Heating Up:** With abundant supply from major sources such as the United States and the Middle East and rising import appetites elsewhere, LNG’s future is robust. LNG production and shipping technologies, particularly FLNG, are maturing and more quickly moving supply to demand-heavy markets, which should prompt more players — and regional consumers — to step up. More than ever before, today’s technological advancements offer the ability to monetize stranded gas resources and to serve isolated demand pockets.

**Trade Dispute:** In late 2018, the specter of an all-out trade war was looming large over the global gas market, particularly for LNG. China responded to U.S. tariffs on $200 billion worth of Chinese goods by targeting $60 billion in U.S. exports, including a 10 percent tariff on U.S. LNG. It didn’t take long for the moves to change the global conversation around LNG shipments. Citing difficulties in arranging Chinese customers because of the trade dispute, Australia-based LNG Ltd said it was delaying a final decision on whether to build its U.S.-based Magnolia LNG plant in Louisiana.

Tariffs on U.S.-produced LNG would raise the cost of transporting natural gas to Chinese customers, dramatically changing the fortunes of U.S. producers counting on Asian demand. The dispute also challenges the natural gas investment market, as tariffs stood to jeopardize proposed gasification facilities and open the door for competitors in other regions to fill the gaps.
Ramping Up Renewables: Momentum for renewables remains tempered by the scalability challenges when higher penetration is targeted. Energy storage has yet to fully resolve seasonality and intermittency issues, and, despite falling costs, financial investments required for large-scale deployments aren’t trivial. More broadly, uncertainty persists about how quickly electrification can be achieved. Despite California’s accelerated renewables road map, the question is especially relevant given that power generation (which is targeted by the 100-percent renewables mandate included in the recent state law) only accounts for one-third of California’s natural gas use with residential, commercial and industrial uses accounting for the remaining two-thirds of natural gas consumption. The state’s switchover is expected to be complex, time consuming and potentially expensive.

New scenarios are emerging that pair storage with conventional gas turbine generation to deliver more rapid response, milder ramp rates, fewer starts and stops, and emissions reductions.

Building a Bridge
It is believed that a significant component of the world’s energy demand will, over the long term, depend highly on natural gas in roles ranging from primary to complementary. In Europe, for instance, BP’s recent Energy Outlook shows natural gas holding and even gaining market share, as gas and renewables are each projected to contribute a share equal to oil in the energy mix.

Economic development and industrialization within the emerging economies of Asia and Africa are creating a thirst for energy. Demand in China, India and other Asian countries that are not members of the Organisation for Economic Co-operation and Development (OECD) account for two-thirds of this growth in energy consumption, drawing strongly upon natural gas.

The link between gas and renewables can be stronger than mere siloed parts of a diverse power portfolio. For example, new scenarios are emerging that pair storage with conventional gas turbine generation to deliver more rapid response, milder ramp rates, fewer starts and stops, and emissions reductions. Battery storage-augmented gas turbines are being explored by some American utilities. With reliability and responsiveness driving investment, cost-effective natural gas assets will continue to have a place in meeting global energy needs — especially in emerging markets where energy needs are immense and all options are on the table. And in regions where renewables are maturing, their increasing penetration still requires an increase in the amount of natural gas-fired backup to accommodate the faster up and down ramping requirements of electric generation caused by distributed energy resources. Additionally, although much of the current discussion is on the use of natural gas for power generation and its interplay with renewables growth, natural gas demand for industrial uses and transportation is also expected to grow significantly.

Global market forces demonstrate that natural gas is neither an absolute solution nor a “has-been.” It’s a major, clean-burning catalyst for reliable energy across the globe, and its expanding role in key markets, both on the import and export sides, confirms that.
GLOBAL MARKET FORCES

LIQUEFIED NATURAL GAS CONTINUES GROWTH TRAJECTORY WHILE CHALLENGES LINGER

By Shawn Hoffart

In the United States, it’s become somewhat of a modern gold rush: drillers racing to free deeply trapped natural gas to quench rising global demand, fueled by an accelerating migration away from coal and the desire for cleaner-burning, greener power options.

Global natural gas demand grew in 2017 by 3 percent, the highest increase since 2010, the IEA recently reported amid predictions that the global gas trade will rise from one-third in 2017 to nearly 40 percent in 2023, propelled by emerging markets. Chief among them are China and India, which as the world’s most-populous countries, can’t get enough of the natural resource and are rapidly expanding their infrastructures to boost their capacities for more LNG that’s been super-chilled to enable safe, more stable shipping.

The U.S. is eager to quench more of that demand, having emerged last year as an annual net natural gas exporter for the first time in nearly six decades as its build-out of export terminals presses on. According to the IEA, the U.S. accounts for nearly 45 percent of growth in global production and nearly three-quarters of LNG export growth.
At least for now by many metrics in the notoriously speculative sphere of energy, these are optimistic and opportunistic times for LNG despite potential challenges that include widening adoption of renewable energy.

According to the IEA’s 2018 annual gas market report, China’s growing LNG imports, greater industrial demand and rising U.S. production through its shale exploration revolution — accounting for two-thirds of domestic output — signify major shifts that will shape the evolution of global natural gas markets over the next five years. Although U.S. LNG developers face challenges that include regulatory hurdles in getting terminal projects to construction, the IEA expects the U.S. to account for three-quarters of the global growth in natural gas exports over the next half decade.

The U.S.-China trade dispute notwithstanding, the IEA’s estimate reflects U.S. exuberance about its opportunities to flourish with LNG, which has reached dozens of foreign destinations on at least four continents.

One of the world’s most-watched markets is Australia, which is bidding to become the world’s largest exporter of LNG on the backs of long-term contracts with Japan, China and South Korea. Australia’s LNG export earnings are projected to reach nearly $40 billion annually by 2023, according to the country’s Department of Industry, Innovation and Science. The nation’s FLNG prospects are high as well, underscored by Royal Dutch Shell’s FLNG facility Prelude, which recently took on gas for the first time in preparation for delivering LNG to global markets.

Yet, Australia’s LNG prominence seems paradoxical: The nation faces unique challenges regarding the impact of its massive exports on domestic natural gas prices. This is something the governments in several territories are trying to address as other major players begin developing import terminals in the southern part of Australia. Proposed import facilities include both land-based and floating regasification units in conjunction with new gas pipelines. Those facilities would import LNG from the spot market and could still be competitive with the current domestic gas prices.

In sub-Saharan Africa, the bonanza of vast, largely untapped natural gas reserves has positioned the region for a potential wave of development as it strives to meet its energy security goals. Trillions of cubic meters of natural gas — the biggest global find of the fossil fuel in decades — are believed to be in a basin off the coast of Mozambique, widely expected to become a force on the global LNG stage in the next decade.

Another offshore natural gas field near South Africa is believed to hold at least 540 billion cubic feet of recoverable reserves. Below that country itself, according to the U.S. Energy Information Administration, there’s an additional estimated 390 trillion cubic feet of onshore shale gas reserves, making that the eighth-largest holder of technically recoverable shale gas in the world, though reaching it has been elusive because of regulatory delays and technical issues. Gas reserves also have been pinpointed in Angola, Ghana, Malawi, Nigeria and Tanzania, offering the region a once-in-a-generation opportunity to capitalize.

**These are optimistic and opportunistic times for LNG despite potential challenges that include widening adoption of renewable energy.**
Intent on making the most of that, the U.S. Agency for International Development’s Power Africa initiative recently launched the Gas Roadmap for sub-Saharan Africa. Built on the premise that there’s potential for roughly 400 GW of gas-generated power in the region, that blueprint seeks to add about 16,000 MW of gas-fired power in nine countries by 2030. With demand from commercial and industrial organizations for higher levels of access and reliability, this initiative can help drive investments from U.S. companies of upwards of $175 billion in gas-to-power projects. That, along with exploration spending and the continued buildout of infrastructure to accommodate its output in Mozambique and beyond, presents the region with a possible path to prosperity and a resounding answer to the public’s growing demand for low-carbon energy.

IEA Chief: ‘Gas Has a Bright Future,’ Though Challenges Remain

According to the 2019 Strategic Directions: Natural Gas Report survey of natural gas industry leaders, roughly one-third of respondents cast themselves as very optimistic about the future growth of the oil and gas sector for the rest of this decade. In 2017, only 13 percent felt that way. An additional 54 percent of the respondents in 2018 considered themselves “optimistic,” up from roughly 45 percent in 2017. Such enthusiasm from 2020 to 2030 remained flat over last year, with slightly more than 60 percent feeling optimistic in some form, according to the polling by Black & Veatch (Figure 4).

According to the IEA, the industrial sector supplants power generation as the chief driver of global natural gas demand growth, with the bulk of that increase coming from emerging markets — largely in Asia — that require the commodity to fuel industrial processes and for feedstock for chemicals and fertilizers. China, driven by continuous economic growth and strong policy support to curb air pollution, will account for 37 percent of the global rise in natural gas consumption between 2017 and 2023, ultimately becoming the world’s biggest importer of the fossil fuel, the agency said.

“While gas has a bright future, the industry is not without its challenges,” including the need for gas prices to remain affordable relative to other fuels in emerging markets, said Fatih Birol, the IEA’s executive director.

FIGURE 4

What is your general outlook on the future growth of the global oil and gas industry?

Between Now and 2020 | Between 2020 and 2030

<table>
<thead>
<tr>
<th>Year</th>
<th>Very Optimistic</th>
<th>Optimistic</th>
<th>Neutral</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>44.8%</td>
<td>31.8%</td>
<td>13.1%</td>
<td>10.4%</td>
</tr>
<tr>
<td>2018</td>
<td>54.1%</td>
<td>32.5%</td>
<td>11.9%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Very Optimistic</th>
<th>Optimistic</th>
<th>Neutral</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>48.6%</td>
<td>28.3%</td>
<td>8.5%</td>
<td>14.6%</td>
</tr>
<tr>
<td>2018</td>
<td>47.9%</td>
<td>27.8%</td>
<td>9.8%</td>
<td>14.4%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
China, driven by continuous economic growth and strong policy support to curb air pollution, will account for 37 percent of the global rise in natural gas consumption between 2017 and 2023.

Royal Dutch Shell, the world’s biggest LNG trader, recently announced plans with partners to build a gas-liquefaction and expert terminal in western Canada’s coastal British Columbia, home to sizable shale reserves. Believing global LNG demand will double by 2035, the project’s developers strategize that by building now, the LNG buyers will come. And, Shell says, the site’s relatively short shipping distance to northern Asia will allow it to compete with LNG shippers to that continent from the Gulf of Mexico through the Panama Canal.

“We believe LNG Canada is the right project, in the right place, at the right time,” Ben van Beurden, Royal Dutch Shell’s CEO, said in a statement. “Supplying natural gas over the coming decades will be critical as the world transitions to a lower carbon energy system.”

**Increases in Investment Support Optimism**

Underscoring similar forward-thinking optimism, oil and natural gas drillers are planning to pump up their borrowing, according to a survey released in September 2018 by Haynes and Boone, an international law firm that tracks oil and gas bankruptcies. More than three-quarters of companies that responded say they’ll borrow more despite market challenges, including the vexing issue of pipeline capacity shortcomings and bottlenecks.

To be sure, whether or not to build a new LNG export terminal is a lengthy, highly complex and multi-billion-dollar decision. Such projects require major financing and, most certainly, the foresight to launch plans now, knowing that getting regulatory approvals even before the first shovel of dirt means such projects take years to become a reality.
FLNG SOLUTIONS PROVE MUCH MORE THAN POTENTIAL

By Javid Talib

It was roughly a decade ago when the initial introduction of floating liquefied natural gas (FLNG) solutions sought to help bring uneconomic gas reserves offshore, such as those in remote locations, to the market. Over the past few years, however, we’ve watched as offshore FLNG capabilities have moved closer to the mainland, offering a very flexible and economical solution to operators looking to offload their supply around the world.

Early adopters of this inventive strategy looked to supply their end users quickly, efficiently and economically, and in 2018, we saw the first major successes. Golar LNG’s Hilli Episeyo’s maiden shipment from Cameroon to China and Shell’s Prelude FLNG vessel receiving its first delivery of LNG for commissioning are more than just major milestones. They have opened the door to what’s possible by better serving the world with a critical reliance on diversified energy.
LNG production and shipping technologies, particularly FLNG, have now been proven and are rapidly gaining momentum for moving supply to demand-heavy markets. Demand for gas in India and China, despite that country’s push to meet renewable energy goals, reflects an all-encompassing approach to power generation that should keep natural gas in the discussion for years to come.

Just as one would weigh the viability of any capital investment decision, however, FLNG solutions must make sense financially to take hold in the market. That’s why it’s no surprise that nearly two-thirds of the 2019 Strategic Directions: Natural Gas Report survey respondents listed return on investment as a major driver for making FLNG investment decisions, followed by lower CAPEX/OPEX at 55 percent (Figure 5).

FLNG offers a faster return on investment than its land-based rivals as it results in a shorter period from final investment decision (FID) to commercial operation. Proliferation of FLNG projects hinges on the ability to get them financed, and while FLNG solutions are both complex and technical, it’s the financial element that can present the most roadblocks. While international oil companies such as Shell have the means to fund these projects internally, smaller outfits must make the financial forecast of their FLNG operation look appetizing to investors.

**FIGURE 5**

What are the major drivers for making FLNG investment decisions? (Select top three choices)

<table>
<thead>
<tr>
<th>Driver</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on investment</td>
<td>62.1%</td>
</tr>
<tr>
<td>Lower CAPEX/OPEX</td>
<td>55.2%</td>
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<tr>
<td>Offtake commitments</td>
<td>39.7%</td>
</tr>
<tr>
<td>Schedule (speed to commercial operation)</td>
<td>32.8%</td>
</tr>
<tr>
<td>Geopolitical risk</td>
<td>29.3%</td>
</tr>
<tr>
<td>Bankability for securing financing</td>
<td>25.9%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch

LNG production and shipping technologies, particularly FLNG, have now been proven and are rapidly gaining momentum for moving supply to demand-heavy markets.
With the successful delivery in the books from the world’s first converted FLNG vessel, the Hilli Episeyo, suddenly traditional on-land baseload LNG export production plants aren’t the only viable options. FLNG facilities also are proving to be a lower-risk opportunity for investors because they offer a quicker speed to market, aren’t fixed to one location and have greater operational flexibility with smaller trains. Another key advantage is that they can be built by repurposing existing assets. FLNG projects also have a smaller footprint with a lower CAPEX burden.

For example, by using our patented PRICO® technology on the Hilli Episeyo, Black & Veatch is able to leverage PRICO’s minimal equipment requirements and compact process footprint, making it an ideal choice for clients pursuing offshore liquefaction solutions. FLNG operations with multiple smaller trains also benefit from providing manageable offtake capacity to serve single or multiple sales contracts, all while being built within the controlled environment of a shipyard anywhere in the world. The benefits of not having to wait for local permitting processes to break ground while ensuring consistent high quality in a controlled environment of a shipyard cannot be overstated.

Operators are realizing the benefits of shifting away from massive baseload plants on land, and when asked what Hilli Episeyo’s maiden voyage’s impact on the industry would be, the majority (67 percent) of survey respondents predict that small- to mid-scale FLNG operations will become more popular (Figure 6).

This approach bucks the “bigger is better” orthodoxy, or at the very least the notion that more size is more economical. Having a smaller operation run with multiple, smaller trains allows the project to be compartmentalized into smaller financial packages that investors are more likely to support. In addition, running one 10-million-ton train at a facility, versus multiple 2-million-ton trains, carries special risks.

**FIGURE 6**

How do you think the industry will be impacted now that the world’s first converted FLNG vessel is in successful commercial operation? (Select all that apply)

- Small to mid-scale FLNG projects will become more popular: 67.3%
- More developers will enter the market: 63.5%
- Industry will look for more conversions versus new FLNG vessel builds: 44.2%
- Financing will be easier to secure for FLNG projects: 30.8%

Source: Black & Veatch
For example, if one 10-million-ton train needs maintenance, malfunctions or goes offline for any reason, the facility’s production halts altogether. Having multiple trains not only maintains uptime but also offers flexibility for meeting the needs of offtakers. With natural gas as cheap as it is today, the market strongly favors the buyer. Gone are the days of long contracts; therefore, securing offtakers for the supply becomes much less predictable. A 10-million-ton train running at one-third capacity suddenly isn’t a very efficient allocation of resources.

Combining a favorable position with lenders with the global energy demand forecast — BP’s 2018 Energy Outlook predicts a 1.2-percent year-over-year increase — makes it understandable to be excited about the future of FLNG. LNG is a clean fuel without the intermittency issues that renewables face today, and as energy projects spring up across the globe, developers are entering the market as confidence in the economics of smaller-scale LNG soars. In fact, 64 percent of survey respondents believe more developers are likely to enter the market in the wake of the recent Hilli milestones.

When developers aren’t in positions to satisfy guarantee demands of lenders, particularly when project costs reach into the billions of dollars, it becomes exceedingly difficult to make progress on large-scale projects. This applies to both large FLNG and land-based facilities. Developer entry into the market is a strong indication that the successes of small to mid-scale FLNG facilities are putting investors at ease.

In today’s low-priced environment, it’s critical that investors start seeing their return as quickly as possible. The larger land-based LNG facilities are more complex, can’t scale down to match fluctuating offtaker demand and can take upward of four to five years before coming online. FLNG is simply a faster solution for moving supply with a much lower financial risk for investors.

Now that FLNG as a solution for monetizing and exporting from both nearshore gas reserves and land-based pipeline networks has proven to be feasible, what’s next? The demand for cleaner, cheaper energy is on a steady incline, and the operational and financial flexibilities of FLNG are on full display. With a more efficient and economical solution now a reality on the open market, operators and developers are primed to explore just how far this ship can take them.
FOUR BIG TRENDS IN GAS-TO-POWER HOLD PROMISE FOR U.S. MARKET

By Alap Shah

Major energy shifts are afoot, and the United States will play a critical role going forward. The EIA projects that by 2022, the U.S. will become a net energy exporter, according to its newly released Annual Energy Outlook 2018. For natural gas, this shift will happen even earlier, around 2020, the EIA says.

The U.S. has become a major player in the global energy market, particularly when it comes to LNG. Armed with prolific amounts of natural gas, major suppliers are investing heavily in liquefaction. This, paired with strong international interest in converting oil-based power generation to gas-based power generation, sets the stage for the United States to play a large role in the world market.

Alap Shah is a Vice President and Director of Technologies and Services Areas in Black & Veatch’s power business. He has more than 20 years of experience serving as Thermal Performance Section Leader and Turbine Technologies Manager. Shah has worked closely with major turbine original equipment manufacturers such as General Electric, Siemens and Mitsubishi Hitachi Power Systems Americas in various turbine technology assessments and several first-of-a-kind turbine technology launches for Black & Veatch.
North America Will Dominate LNG Exports

The south-central region of the U.S. is gushing with an oversupply of natural gas. The area is home to the massive Permian Basin, which stretches from southeastern New Mexico across west Texas, an area that is flush with associated natural gas, a byproduct of oil production.

As a result, American gas is cheap and plentiful, and major suppliers are making moves to capitalize on its availability. Because prices for natural gas are so low — and prices for oil remain high — the international market is taking note. Driven by global demand, major suppliers are now investing significantly in liquefaction facilities along the south-central coast of the U.S. — namely, the Gulf Coast — to turn this cheap gas into LNG, which is relatively easy to transport and requires minimal infrastructure.

Currently, the U.S. operates two LNG export facilities — Sabine Pass on the Louisiana/Texas border and Cove Point in Maryland — with four new facilities under construction in Texas and Louisiana that are scheduled for completion this year. A tremendous buildup of liquefaction capacity is expected as the U.S. continues to serve as the world’s net exporter of natural gas.

Because prices for natural gas are so low — and prices for oil remain high — the international market is taking note.
Growing Opportunity in the International Market

Natural gas oversupply and persistent low prices are making gas-to-power conversions increasingly attractive to the rest of the world. Countries that convert from oil to gas, particularly those that have traditionally run on diesel fuel oil, can cut their electric costs in half, balance their energy portfolios and comply with environmental regulations.

Case in point: One combined cycle project under way in Puerto Rico cost $30 million to convert from oil to natural gas. Based on current oil prices and the current low cost of LNG, the island nation stands to save approximately $20 million per month on power costs — not to mention the environmental benefits of powering a plant off natural gas rather than oil.

As a result, many developing regions are establishing gas-to-power markets that can accommodate imported supply. Island nations and coastal nations are prime targets, as integrated LNG receiving terminals and gas-fired generation plants can be built along their shores. There is growing interest in FLNG applications, which have a number of benefits over land-based LNG facilities, such as quicker, more flexible deployment schedules and reduced shoreline impacts.

New opportunities are arising in Africa (Ghana), Brazil, the Caribbean, Indonesia and East Asia.

Earlier this year, Ireland announced that it would invest €500 million in infrastructure designed to boost its supply of renewable gas. Another big move is to bring gas to the Baja California region of Mexico, where most of the power generation is from oil.

Brexit Implications on Gas Market

The ramifications of Brexit, the United Kingdom’s contentious exit from the European Union (EU), will have an impact on the global natural gas market. The UK has trading agreements in place to protect the vital interconnector flows that supply Ireland, the UK and western Europe with natural gas. Because so many parties benefit from these flows, it remains likely that the trading agreements will remain largely protected. In the case of a “Hard Brexit” — where the UK walks away from the negotiating table rather than take a deal it considers insufficient — the UK system is set up in such a way that it could easily ramp up global LNG imports from countries other than in the EU, including the United States.

Russia continues to be the largest exporter of natural gas to Europe and the UK. But amid tightening tensions with the Kremlin, expect to see the EU, and the rest of the world, turn to new opportunities for cheap gas.
Trend: Battery Storage-Augmented Gas Turbines

Gas turbines and renewables are beginning to solve each other’s problems. Turbines have long played a central role in helping supply meet demand, given their ability to quickly flex up or down to demand peaks and dips. But their efficiency is diminished when running under or above optimal load.

Meanwhile, the rise of renewable energy sources promises to reduce our carbon footprint, but they also carry hazards for utility managers, as their variability and intermittency complicate load-balancing and grid-planning efforts. Enter the battery storage-augmented gas turbine, in which storage performs as a kind of reserve that springs to life to smooth and optimize turbine performance levels.

Conclusion

From the evolution of LNG and liquefaction to changes in gas production and transport, the volume of natural gas available to the global market is dramatically changing. No matter which direction the market winds blow, these trends and many others point to the U.S. bolstering its standing on the global natural gas stage. It promises to be an interesting decade, as the world’s thirst for natural gas reshapes the future of American energy exports.
MARKET STRIVES TO DELIVER OVER PIPELINE CHALLENGES

By Denny Yeung

As if the persistent low-price environment wasn’t enough, rampant natural gas production in the Appalachian and Permian Basins is ramping up concern that pipeline take-away capacity can’t keep up. This comes as the United States natural gas industry prepares to enter one of its strongest growth periods to date, driven by increasing global demand for low cost natural gas supplies and growing domestic demand for cleaner energy sources.

Unfortunately, this rising demand comes during a slowdown in interstate pipeline development. Projects have been delayed for various reasons tied to the approvals process and local opposition. Recently, the Atlantic Coast Pipeline and the Mountain Valley Pipeline lost their construction permits for a month due to a faulty right-of-way through national park land. Both pipelines are expected to be completed by the end of 2019, providing 900 miles of new pipeline to transport natural gas throughout the Southeast. Delays in the development of transportation have trickle-down impacts on the availability of gas production and the price consumers pay around the globe.

Denny Yeung is a principal consultant with Black & Veatch Management Consulting. Yeung has more than a decade of experience in market analysis, asset valuation and financial analysis for natural gas and has led numerous engagements in market assessments and due diligence review of midstream assets. As the interstate pipeline market lead, he has led the detailed modeling of fundamental factors in the North American natural gas market.
A Market in Need, Without Recourse

The New England market, where supply remains heavily constrained on peak winter days, is most in need of incremental pipeline capacity over the next five years, according to Black & Veatch’s 2019 Strategic Directions: Natural Gas Report survey. The Mid-Atlantic region ranked second, with the Southeast region coming in third, marking a strong need to build additional infrastructure (Figure 7).

Ironically, the nearest source of natural gas — the Appalachian Basin, home to the Marcellus and Utica shale plays — is far and away the most abundant in the U.S. According to the EIA, natural gas production in the Appalachian region has grown from 7.9 billion cubic feet per day (Bcf/d) in 2012 to 26.9 Bcf/d in 2018, based on EIA data through August 2018.

But delivering large volumes of natural gas to New England will require miles and miles of interstate pipeline, and to this point, most attempts to build capacity into New England have stalled due to a complicated blend of local opposition, interstate compliance issues and state regulatory approvals.

It’s no secret that producers need to expand their processing and transportation capacity throughout this region. By 2025, industry leaders say up to 5 Bcf/d in additional incremental pipeline capacity would be required to transport natural gas out of the Appalachian Basin.

Increasing Regulations, Costs

The next tranche of pipeline capacity is certain to be more expensive than any other development done to date, and this will become apparent over time in both brownfield and greenfield expansions. According to survey results, local and environmental opposition and the Federal Energy Regulatory Commission (FERC)/state approval process are the two most important issues concerning pipeline development, with market support and rising costs a closely entwined third (Figure 8).

Public opposition and environmental concerns have the potential to not only disrupt but halt pipeline development work. The Atlantic Coast Pipeline and Mountain Valley Pipeline projects
continue to be fiercely contested, and the actions of protestors have garnered headlines throughout the U.S. Both projects have faced numerous court challenges after questioning whether the project’s impacts had been adequately considered.

With rising pipeline costs, potential shippers and regulators are challenging the need for pipeline capacity and evaluating alternative options.

FERC is taking a harder look at how to address the procedures to approve interstate pipelines at the federal level. In 2018, the federal agency announced it was launching a Notice of Inquiry “seeking information and stakeholder perspectives to help the commission explore whether, and if so, how, to revise existing policies regarding its review and authorization of interstate natural gas transportation facilities under section 7 of the Natural Gas Act.” It is difficult to say how the agency will rule, but either way, there will be challenges ahead to build new pipeline capacity.

Market support ranks a distant third. Local distribution companies (LDCs) have traditionally supported incremental pipeline capacity to serve peak day needs; however, there are several pilot programs across the country aimed at managing peak day needs through demand response of residential and commercial customers. With rising pipeline costs, potential shippers and regulators are challenging the need for pipeline capacity and evaluating alternative options, given the long-term commitment needed for pipeline capacity.

In general, there is a certain rising cost associated with new projects going forward. Construction costs, which continue to rise in response to higher prices for labor and materials, spiked recently in response to the administration’s tariffs on foreign supplies. Foreign steel plays a major role in oil and gas pipeline construction, and the tariffs threaten to slow development.
Investigating Possible Solutions

Unsurprisingly, the industry sees interstate pipeline mainline expansions, LDC systems and interstate pipeline laterals (the smaller lines that connect off the main) playing critical roles when it comes to building out incremental infrastructure (Figure 9).

The survey also indicates a growing need for LDCs to either reinforce or expand the local distribution systems. Many facilities/end users rely upon the LDCs to make the last mile of delivery, and there is a need to expand and reinforce those systems to move gas safely from the interstate pipeline right to the burner tip.

The lesser support for greenfield pipeline additions reflects the general sense in the industry that greenfield pipelines are going to remain more difficult to build. Greenfield expansions are particularly more challenging because companies must secure new rights-of-way. This means obtaining the necessary approvals, working with land owners, and obtaining federal- and state-level approvals after court challenges by opposition groups.

FIGURE 9

What types of incremental infrastructure will be most needed to serve emerging gas demand? (Select all that apply)

<table>
<thead>
<tr>
<th>Infrastructure Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate pipeline mainline expansions</td>
<td>66.0%</td>
</tr>
<tr>
<td>Local distribution company systems reinforcements/expansions</td>
<td>55.0%</td>
</tr>
<tr>
<td>Interstate pipeline laterals</td>
<td>50.6%</td>
</tr>
<tr>
<td>Greenfield pipeline additions</td>
<td>30.1%</td>
</tr>
<tr>
<td>LNG peakshaving/traditional reservoir storage</td>
<td>27.7%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
Planning for the Future

Educating the public and key stakeholders will remain critical to assuage opposition going forward. Land owners, energy consumers, and state and federal regulators need to understand the benefits of natural gas and pipelines, in general, and how they support the local and state economy by providing low cost reliable energy while also supporting green economy initiatives.

North American gas demand growth is seemingly inevitable over the next decade; however, gas pipeline capacity could be the critical link for gas production to keep pace and allow low cost gas supplies to reach local and global end use markets.

Expect to See Build-out in the Permian Basin

As oil prices continue to rise, increasing production of both oil and associated natural gas, activity in the Permian Basin will continue to pick up. In addition, growing demand in Mexico for cheap natural gas will foster the development of new pipelines to move the gas south across the border.

The Permian Basin boasts two major benefits over the other regions:

- Its proximity to the Gulf Coast allows access to LNG export facilities. There are currently two LNG export facilities in operation, with four new facilities under way in Texas and Louisiana. According to the EIA, once completed, these facilities will allow the United States to export more than 10 Bcf/d.
- Intrastate pipeline development will make the approvals process smoother and quicker, as most of the pipelines will be constructed within Texas state lines, reducing the need for federal oversight with its lengthier, more complicated approvals process.

To target growing demand in the Gulf Coast market, producers have already identified several development projects, but there will be another tranche of expansion that has yet to be identified. As a result, expect to see a slew of new pipeline projects crop up.
Global Perspectives

SOUTHEAST ASIA’S JOURNEY TOWARD A CLEANER ENERGY FUTURE

By Rochman Goswami

Strong economic growth, low gas prices and environmental goals are transforming natural gas demand in Southeast Asia.

The IEA forecasted in its Southeast Asia Energy Outlook 2017 that demand for natural gas will grow 60 percent by 2040, because of rising consumption in power generation and industry. Research and consultancy firm Wood Mackenzie estimates that by 2035, more than half of the region’s gas demand will be met by LNG.

Thailand expects that its LNG imports via long-term contracts will climb to 35 million tonnes per year (mmtpa) by 2036 from 5.2 mmtpa in 2017. In response, it plans to double its annual regasification capacity to 20 mmtpa from the current 10 mmtpa in the next 10 years. At the same time, state utility Electricity Generating Authority of Thailand (EGAT) is planning its own 5 mmtpa floating storage regasification unit (FSRU) in the Gulf of Thailand. The FSRU, expected to be ready by 2024, will be linked to Thailand’s existing gas pipeline network.

China’s demand for LNG imports reflects its policies to discourage coal burning for electricity. Wood Mackenzie forecasts that China’s demand could reach 330 billion cubic meters (Bnm³) by 2020 from 206 Bnm³ in 2016.

Growth of natural gas is fueled by:

- Low cost supplies
- Greater demand from developing economies due to rising urbanization/industrialization
- More abundant LNG resources making gas available to previously inaccessible markets
The opportunity is in expanding LNG’s role to provide flexible power generation to balance the electricity grid in Southeast Asian countries.

As a feedstock, natural gas has many advantages. Compared to emissions from coal-fired generation, natural gas produces half as much carbon dioxide, less than a third as much nitrogen oxides and 1 percent as much sulfur oxides, according to the U.S. Environmental Protection Agency. In areas where air quality needs improvement, gas is a viable alternative.

Compared to coal and renewable energy, natural gas offers power providers the shortest startup time. The ability of gas-fired power stations to ramp-up more quickly than those using other feedstocks means they can be considered a viable baseload option for communities using power from renewable sources.

There are opportunities for microgrids to rely on gas-fired generation as the primary baseload power for integration with intermittent renewables. For example, there is an increased interest in using natural gas-fired reciprocating internal combustion engines (RICE) for microgrids. Because RICE power is quickly available on demand and can run on clean, low-cost gas, it is often the microgrid selection to backstop distributed generation.

Key trends driving opportunities for natural gas in distributed energy resources systems:

- Swiftly falling cost of wind and solar technology
- Improvements in battery storage from both a technological and economic perspective
- Rampant growth of electrification, driven by the proliferation of electric vehicles

The IEA suggested that LNG can be used in smaller scale projects in archipelagic countries, such as Indonesia and the Philippines, where it can replace diesel-based generation in some island communities. In addition to environmental improvements, converting to gas power can, in some cases, cut electricity costs in half.
Infrastructure Investments

To meet growing electricity demands, industry experts predict that Southeast Asia will become a net importer of gas by the mid-2020s.

The prediction has important implications for infrastructure development in the region. Increased investment in import infrastructure, such as receiving terminals, pipelines, power generation and other infrastructure that receive, distribute and use gas, is necessary to support the expanded use of natural gas. The receiving terminals will increase the flexibility of gas procurement as well as create sustainable LNG supplies.

In congested Southeast Asian cities where land acquisition is a challenge, floating solutions such as FSRU and FLNG could be feasible investment alternatives to onshore infrastructure.

FSRUs are less of an investment risk than onshore LNG terminals. If FSRUs are retrofitted from LNG vessels, the investment is even lower. The FSRU’s portability offers greater investment protection while addressing the lack of pipelines and terminal infrastructure. It also removes land acquisition issues.

FLNG applications are more flexible and can be deployed more quickly than onshore LNG import terminals. FLNG and FSRU projects effectively reduce issues of shoreline impacts, size and complexity considerations in development.

Grid Modernization

As plans for LNG import infrastructure advance, the region has the opportunity to reassess the role of gas power plants. One option would be to co-locate new infrastructure that offers a synergy between regasification terminals and gas turbine power stations by utilizing LNG’s “cold energy” to chill gas turbine inlet air. This makes both regasification and gas turbine power stations more efficient and cheaper to operate.

The combustion turbine’s inlet air provides the heat energy to vaporize the LNG using a glycol circulation loop connecting LNG vaporizers and coils in the combustion turbine air inlet ducts. This arrangement significantly increases power station output and efficiency.

Integrating LNG-to-power is complex. However, comprehensive project execution planning and collaboration with other stakeholders in the gas value chain can capture the necessary funding for LNG supply and import infrastructure to achieve maximum return on investments.

At the same time, a transparent regulatory framework would give stakeholders confidence about investing in the industry, while supportive government policies that focus on improving energy security will contribute to the growth of natural gas.

As importers demand cheaper and more flexible terms, establishing regional markets would improve pricing transparency that could stabilize price disputes between buyers and sellers and support market growth. Stabilized prices can facilitate commitment to long-term contracts, which can, in turn, help developers attract new financing capacity. Supportive policies, such as carbon pricing, can serve to strengthen the business case for gas in power generation.

Regional integration of LNG infrastructures is another opportunity for development. The IEA has identified that better interconnection of natural gas supply networks, supported by flexible and transparent markets, can further enhance gas security in Southeast Asia.

For Southeast Asia, solving the infrastructure gaps will help to facilitate deployment and support the growth of gas. Partnering companies with deep engineering, commercial and political experience would mitigate the risks associated with the complex integration of natural gas and electric projects needed to provide energy security.
Report Background

Black & Veatch’s 2019 Strategic Directions: Natural Gas Report is a compilation of quantitative and qualitative data and analysis from industrywide surveys. This year’s online survey was conducted from 28 August through 20 September 2018.

A total of 195 qualified utility, municipal, commercial and community stakeholders completed a majority of the survey. Because the survey was administered online, the amount of self-selection bias is unknown; therefore, no estimates of sampling error have been calculated. The following figures provide additional details on the participants in this year’s survey.
FIGURE 10
In which countries or regions does your organization operate/provide services?

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>90.8%</td>
</tr>
<tr>
<td>Asia</td>
<td>23.1%</td>
</tr>
<tr>
<td>Canada</td>
<td>23.1%</td>
</tr>
<tr>
<td>Europe</td>
<td>17.9%</td>
</tr>
<tr>
<td>Mexico</td>
<td>16.9%</td>
</tr>
<tr>
<td>Africa</td>
<td>13.3%</td>
</tr>
<tr>
<td>Middle East including the GCC</td>
<td>12.3%</td>
</tr>
<tr>
<td>South America</td>
<td>12.3%</td>
</tr>
<tr>
<td>Australia/Oceania</td>
<td>11.8%</td>
</tr>
<tr>
<td>Central America</td>
<td>10.8%</td>
</tr>
<tr>
<td>Other</td>
<td>4.1%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch

FIGURE 11
Which of the following best describes the services provided by your organization?

<table>
<thead>
<tr>
<th>Service</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>21.5%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>23.1%</td>
</tr>
<tr>
<td>Generator/Utility</td>
<td>44.1%</td>
</tr>
<tr>
<td>Other</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
FIGURE 12
GROUP A: OIL
Which of the following best describes the services provided by your organization?

Oil production services (drilling, extraction, recovery of oil) 7.2%
Oil gathering, transportation and storage (pipelines, tankers, trucks) 5.1%
Oil marketing (retail, trading) 1.5%
Oil refining/petrochemicals/liquids 7.7%

Source: Black & Veatch

FIGURE 13
GROUP B: NATURAL GAS
Which of the following best describes the services provided by your organization?

Natural gas marketing 3.1%
Interstate/intrastate pipelines 8.7%
Natural gas producer 3.1%
Natural gas marketing 3.1%
Other natural gas 8.2%

Source: Black & Veatch

FIGURE 14
GROUP C: GENERATOR/UTILITY
Which of the following best describes the services provided by your organization?

Generator/Utility 44.1%
Local distribution companies (LDCs) 27.7%
Utility/Regulated/Merchant electricity generator 16.4%

Source: Black & Veatch
List of Figures

4. FIGURE 1
   To what extent are the following emerging trends likely to shape the global LNG market over the next five years?

11. FIGURE 2
    What is your general outlook on the future growth of the global oil and gas industry?

14. FIGURE 3
    What are the major drivers for making FLNG investment decisions? (Select top three choices)

15. FIGURE 4
    How do you think the industry will be impacted now that the world’s first converted FLNG vessel is in successful commercial operation? (Select all that apply)

6. FIGURE 5
    What is your general outlook on the future growth of the global oil & gas industry?

7. FIGURE 6
    Destination markets in China, India, Southeast Asia and Africa

22. FIGURE 7
    Which of the following markets will be in need of incremental natural gas pipeline capacity over the next 5 years? (Select all that apply)

23. FIGURE 8
    Please rate the importance of each of the following issues and/or challenges related to the building incremental natural gas pipeline capacity. (Select one choice per row)

24. FIGURE 9
    What types of incremental infrastructure will be most needed to serve emerging gas demand? (Select all that apply)
FIGURE 10
In which countries or regions does your organization operate/provide services?

FIGURE 11
Which of the following best describes the services provided by your organization?

FIGURE 12
GROUP A: OIL Which of the following best describes the services provided by your organization?

FIGURE 13
GROUP B: NATURAL GAS Which of the following best describes the services provided by your organization?

FIGURE 14
GROUP C: GENERATOR/UTILITY Which of the following best describes the services provided by your organization?
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