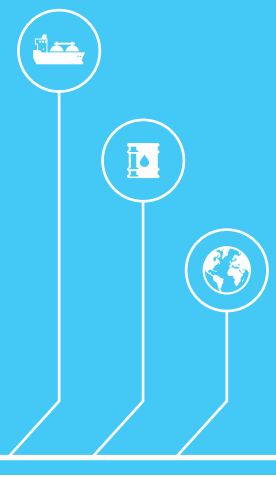
DNV·GL

THE LNG ERA TAKES SHAPE

The outlook for the LNG market



Natural gas is on track to overtake oil as the world's primary energy source by the middle of the next decade. Much of this expected increase in gas supply will be delivered to market as liquefied natural gas (LNG). In fact, DNV GL estimates that global LNG production will increase from 250 million tonnes per year (mt/yr) in 2016 to around 630 mt/yr by 2050.[1]

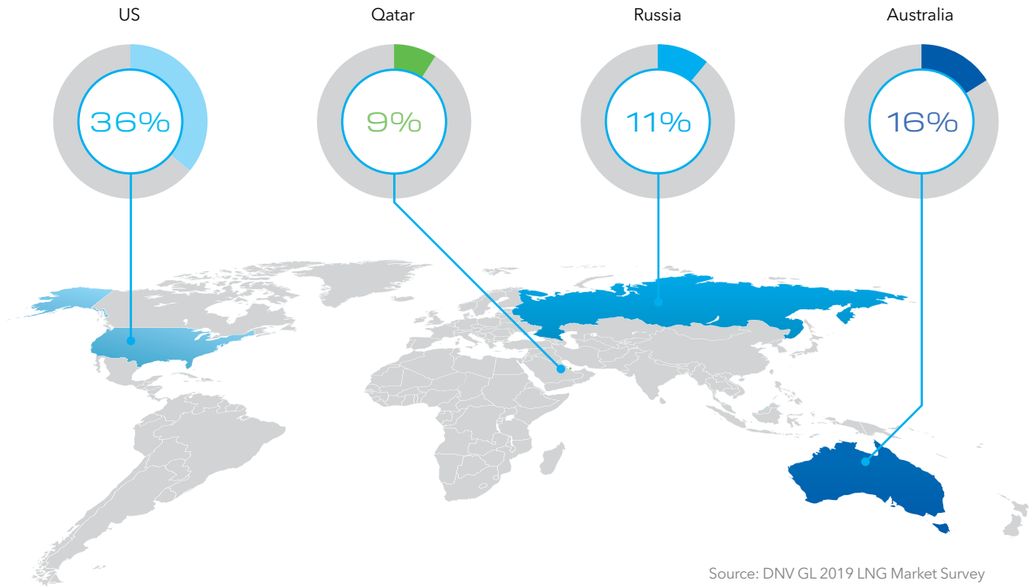
This report explores the key issues driving LNG's increasingly important role in global energy markets, and showcases findings from three of DNV GL's primary research and forecasting projects – the 2019 LNG Market Survey, the 2019 Oil and Gas Industry Outlook Survey and the 2018 Energy Transition Outlook – plus in-depth interviews with industry leaders.

We present several findings relating to the diversification of LNG supply sources, and rapidly increasing demand, as well as the new dynamics in play in global gas markets, including:

- The majority of LNG-focused oil and gas professionals (85%) believes several new LNG infrastructure projects will need to be initiated in 2019 to ensure supply can meet demand post 2025
- Seven in ten (69%) believe price uncertainty is limiting investment in LNG mega-projects
- Nearly three-quarters (72%) believe LNG buyers need more flexibility in LNG contracts (e.g. to reduce volumes, shorten tenures, and change delivery locations).

1 Energy Transition Outlook 2018, DNV GL: http://bit.ly/2HeQLLg

Countries in which respondents expect the greatest growth in LNG exports over the next three years



Source: DNV GL 2019 LNG Market Survey

The globalization of gas

Historically, global gas supply has been dominated by two major pipeline exporters (Russia and Norway) and one major LNG exporter (Qatar). But, since 2014, other sources have grown in prominence, most notably US shale and Australian offshore fields.

Much of this market diversification has been driven by new LNG routes to growing consumer markets. According to our survey of more than 290 LNG-focused oil and gas professionals, the US is expected to have to deliver the biggest growth in LNG exports over the next three years. The expansion of the Panama Canal in 2016 has been key to connecting US LNG to consumer markets in Asia. More recently, the easing of LNG transit restrictions through the canal in 2018 has opened up even more slots for LNG shippers.[2]

Many nations are initiating or expanding investment in LNG export capacity. This includes major projects by established LNG exporters, for example: the four new liquefaction facilities under construction in the US (Corpus Christi, Cameron, Sabine Pass and Freeport[3]); the development of the Barossa, Scarborough and Browse fields in Australia (as well as the deployment of Shell's Prelude floating LNG vessel off Western Australia);[4] and Qatar's plans to increase LNG capacity by 43% over the next five years by investing in four new LNG trains.[5]

Other oil and gas-producing nations are targeting a bigger slice of the LNG market. For example, in October 2018, a Shell-led consortium announced the development of a major LNG project in British Columbia, Canada, which benefits from being a relatively short shipping distance to North Asia.[6] At the Yamal project in Russia, meanwhile, operations commenced at a third LNG train, with a fourth to be commissioned in 2019, which would bring capacity at the nation's largest LNG project to 17.5 mt/yr. [7]

> "Competition in the gas markets is more intense than ever, with several regions now competing in the LNG space."
>
> **Hans Coenen,** vice president, corporate business development, Gasunie

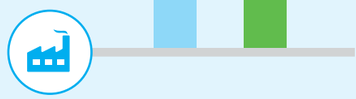
New nations are also looking to develop LNG export capabilities, particularly in Africa. ExxonMobil, Anadarko and Eni are leading the development of several projects in Mozambique,[8] while BP is leading the ultra-deepwater Tortue project, which will see Senegal and Mauritania become LNG exporters from 2022.[9]

"Competition in the gas markets is more intense than ever, with several regions now competing in the LNG space," says Hans Coenen, vice president for corporate business development at Gasunie, which owns the national natural gas transmission network in the Netherlands.

At the same time, transnational gas pipelines remain a strong competitor with LNG supply for a number of reasons, including cost, accessibility, and reliability. However, with natural gas overall expected to overtake oil to become the world's primary energy source in the mid-2020s – and with global gas demand not set to peak until 2034 – there is ample scope for LNG and pipeline gas to grow together, albeit with LNG expanding at a faster rate.[10]

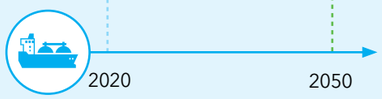
Growth in LNG production and trade

Global LNG production forecast



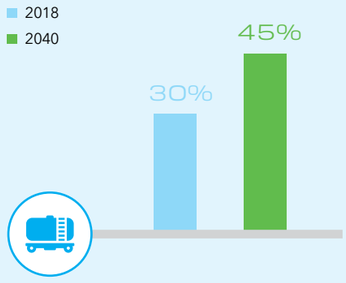
DNV GL's 2018 Energy Transition Outlook – which forecasts global energy markets to 2050 – estimates that global LNG production will increase from 250 mt/yr in 2016 to around 630 mt/yr in 2050.

Global seaborne natural gas trade forecast



The model forecasts an average 2.5% annual rise in global seaborne natural gas trade – LNG and liquid petroleum gas combined – from 391 mt/yr in 2020 to around 780 mt/yr in 2050.

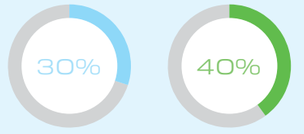
Forecast share of gas transport as LNG



Gas transport as LNG is expected to grow faster than pipeline transport, with the share of gas transported as LNG to grow from 30% today to 45% by 2040.

Top two regions for liquefaction capacity in 2050

- North America's share of global liquefaction capacity in 2050
- Middle East & North Africa's share of liquefaction capacity in 2050

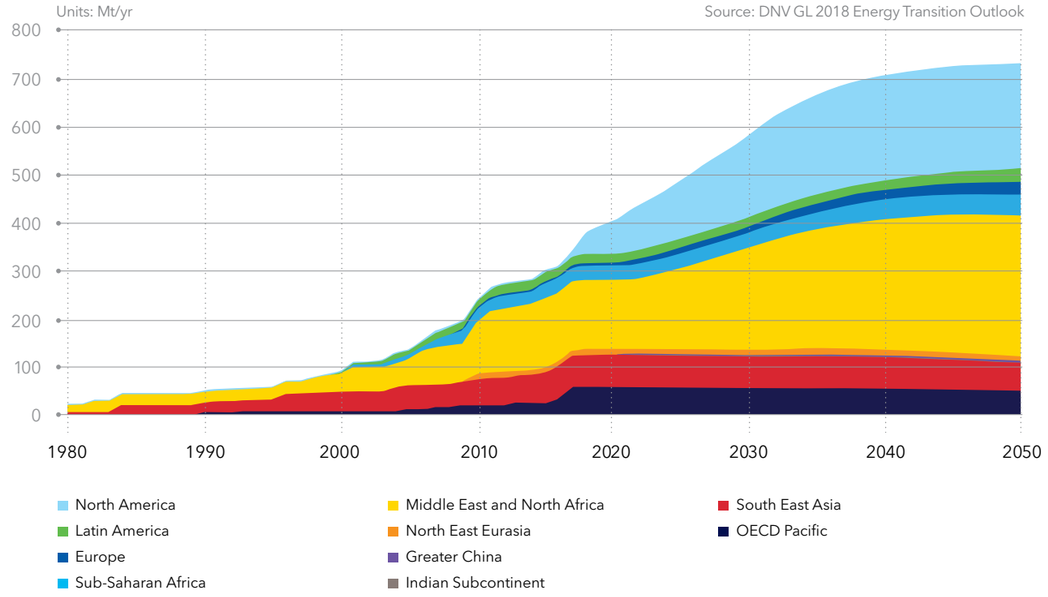


Conventional gas from the Middle East and North Africa, and unconventional gas from North America is forecast to account for 70% of LNG liquefaction capacity in 2050.

Source: DNV GL 2018 Energy Transition Outlook

2 Panama Canal drops LNG transit restrictions: http://bit.ly/2Wjj8KU
3 US poised for major step-up in LNG exports: http://bit.ly/2FprauY
4 Australia grabs world's biggest LNG exporter crown: https://reut.rs/2TUy1qi
5 LNG output surge of 43% by 2024: http://bit.ly/2U4hrnh
6 Shell gives green light to invest in LNG Canada: https://go.shell.com/2RtQtF8
7 Russia's Novatek produces commissioning LNG: http://bit.ly/2uog0BE
8 Big hitters betting on Mozambique: http://bit.ly/2HEemEA
9 Mauritania/Senegal: BP announces FID for Phase 1: http://bit.ly/2JE3qIL
10 Energy Transition Outlook 2018, DNV GL: http://bit.ly/2HeQLLg

LNG liquefaction capacity forecast, by region



Contracts for smaller-sized FLNG vessels

Technology continues to be a significant enabler of gas-supply diversification, including greater exploration and drilling efficiency, longer subsea tiebacks, and improved recovery techniques. FLNG is another example, with substantial growth in the use of FLNG vessels proposed to unlock stranded offshore gas assets. FLNG can be used to load carriers directly, without the need for costly pipeline infrastructure.[11]

Shell's large-scale Prelude FLNG facility has grabbed the headlines for its record-breaking size – Prelude is the largest vessel ever made, at 488 metres (m) long and 74m wide – and staggering cost, estimated to be in the region of USD14bn.[12] However, the future appears to belong to smaller-scale developments.

In our recent survey of LNG-focused oil and gas professionals, 59% said the industry will prefer smaller FLNG projects and tanker conversions over Prelude-sized units. Smaller vessels have many advantages. They are cheaper to build and operate, faster to deploy, and effective at exploiting smaller volumes of stranded gas and at serving the many markets looking to buy smaller volumes.[13]

Eni's Coral FLNG, one of the newest vessels to be purchased, reflects this trend. Construction began in 2018, and when it starts producing (from offshore Mozambique) in 2022, it will generate 3.3 milllion tonnes per annum (mtpa)[14] compared to the 5.3 mtpa expected from Prelude FLNG.[15]

"We are seeing more contractor-led models emerging, which involve smaller, faster, more agile solutions, such as the development of smaller-scale FLNG vessels and the conversion of existing LNG carriers into FLNG vessels," says Graham Bennett, vice president, DNV GL – Oil & Gas. "In those situations, it's not likely that the operator will own the vessel. It's more likely that a contractor will liquify gas on behalf of the operator. This is a way to buy a service instead of a costly asset and thereby reduce risk."

Indeed, more than half (55%) of senior oil and gas professionals believe operators will outsource or lease critical field development assets (such as FLNG vessels) in 2019, according to our 2019 Oil and Gas Industry Outlook Survey.

11 Energy Transition Outlook 2018, DNV GL: http://bit.ly/2HeQLLg
12 Shell takes $14bn gas gamble with world's biggest floating structure: https://on.ft.com/2CBjdlC
13 Smaller FLNG vessels showing outsized potential: http://bit.ly/2OmY2st
14 Eni cuts first steel for Coral South FLNG: http://bit.ly/2Woh3gN
15 LNG Liquefaction Ship – Center for Environment, Commerce & Energy: http://bit.ly/2UVJSAO

China's transformational demand for gas

The People's Republic of China is on track to become the world's largest gas-importing country, and the nation's recent surge in demand for gas has been central to transforming LNG markets globally. In our LNG survey, China is – by a large margin – the country expected to have the biggest growth in LNG imports over the next three years.

This appetite for LNG is driven largely by the Chinese government's "blue sky" policies, aimed at reducing fossil fuel emissions and improving air quality.[16] Indeed, in the DNV GL 2019 Industry Outlook Survey, 72% of senior oil and gas professionals based in China said their organizations' investments in natural gas and LNG were driven by long-term energy transition, compared to just 47% across all respondents globally.

> "China overall still lacks gas, and seasonal gas supply tensions exist."
>
> **Yuan Zhengang,** deputy director, PetroChina Planning and Engineering Institute (CCPEI)

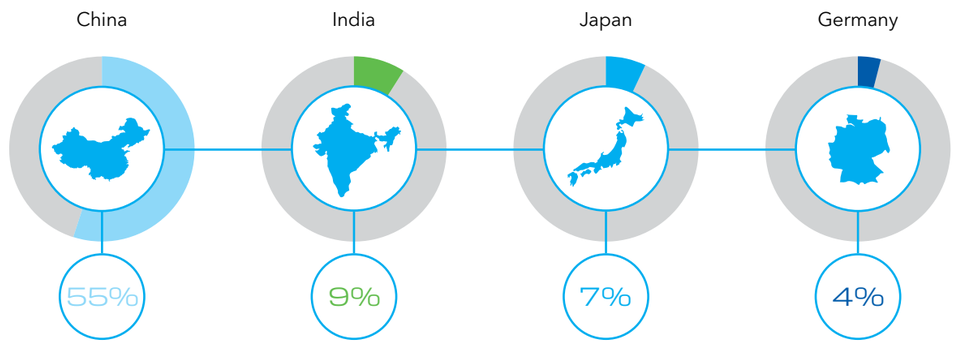
In the first half of 2018, China imported a record 24 mt/yr of LNG, 50% more than in the same period in 2017.[17] But there is significant growth still to come. Gas still only accounts for 7% of China's energy mix today, compared to a global average of 22%.[18]

"China overall still lacks gas, and seasonal gas supply tensions exist," says Yuan Zhengang, deputy director of the Oil & Gas Institute at PetroChina Planning and Engineering Institute (CCPEI). "LNG terminal construction and gas storage projects are set for relatively rapid growth, alongside investments in pipeline network systems and improvements."

Indeed, Sinopec aims to build new infrastructure that will double its receiving capacity of LNG over the next six years.[19] China also has major plans to overhaul and liberalize its national gas pipeline network to ensure gas supply is not hindered by a lack of access to pipeline infrastructure.[20] China's National Development and Reform Commission has recommended that the nation's pipeline network be expanded by 99,000 km between 2015 and 2025.[21]

DNV GL's 2018 Energy Transition Outlook forecasts seaborne gas trade from North America to China to treble by 2050. But China is looking to source LNG from far and wide, and invests in LNG projects around the world.[22]

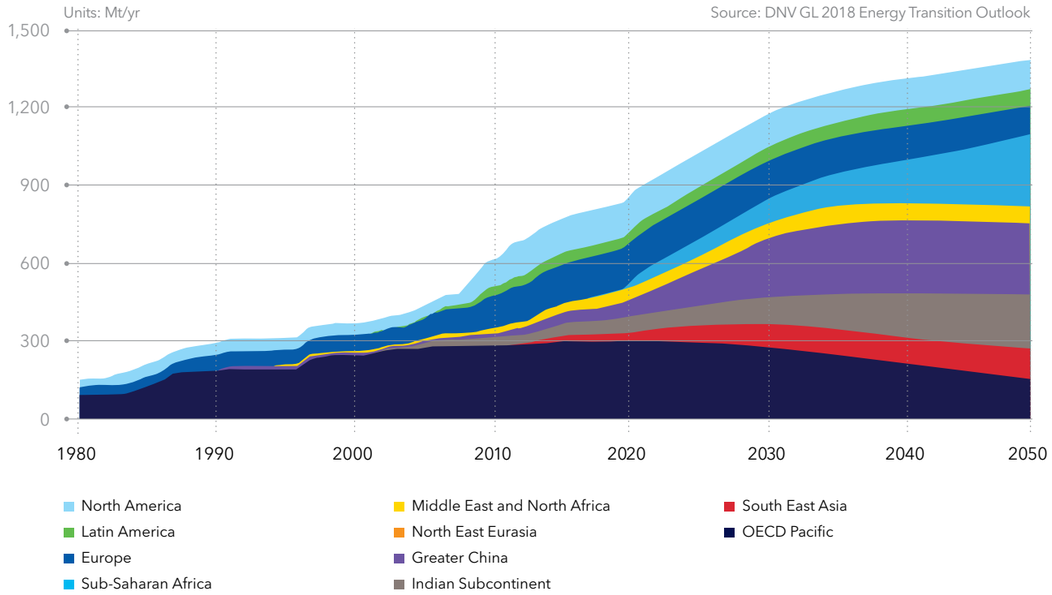
Countries in which respondents expect the greatest growth in LNG imports over the next three years



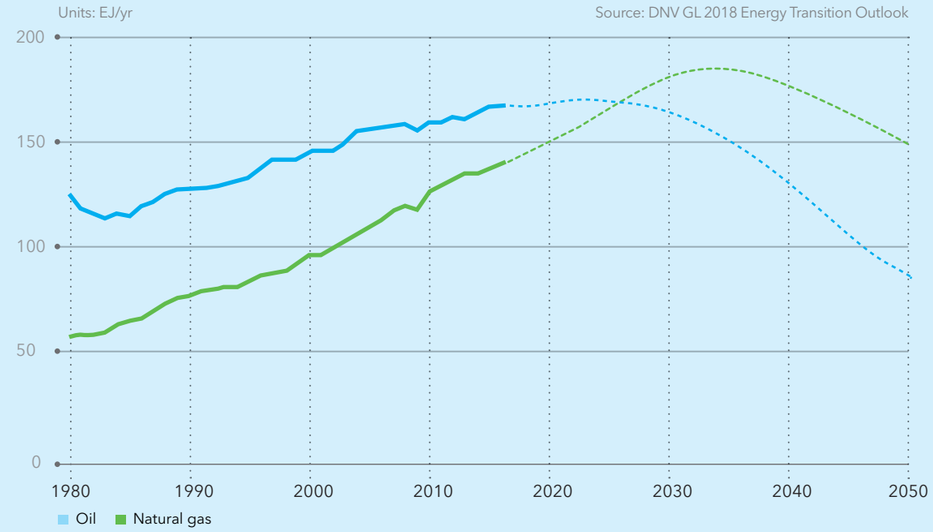
Source: DNV GL 2019 LNG Market Survey

16 February: Signposts for the gas outlook: http://bit.ly/2Tvs8dZ
17 Global LNG Outlook 2018: http://bit.ly/2Tty0EQ
18 February: Signposts for the gas outlook: http://bit.ly/2Tvs8d
19 China's Sinopec to more than double LNG capacity: http://bit.ly/2UbJpxi
20 China's Clean-Air Push Is a Gas Pipeline Behemoth: https://bloom.bg/2JE5INt
21 A Natural Gas Giant Awakens: http://bit.ly/2us8wNT
22 How Is China Securing Its LNG Needs?: http://bit.ly/2Yhlk7D

LNG regasification capacity forecast, by region



Fossil energy use forecast



World gas demand has doubled since 1990. DNV GL's 2018 Energy Transition Outlook predicts that growth will continue for around 15 years, hitting a high in 2034 at a level 30% above that in 2017, before entering moderate decline as renewables account for an ever-increasing share of power generation.

Growth beyond China

China is currently the biggest driver of LNG growth, but it is far from the only nation with rapidly growing demand for LNG or a long-term strategy to build it. Other emerging economies – particularly in the Indian Subcontinent and Sub-Saharan Africa – will also boost demand.

India currently has four LNG receiving terminals, but plans to build 11 more over the next seven years, with the near-term goal of doubling the proportion of natural gas in its energy mix by 2022.[23] Elsewhere in Asia, new LNG importers have emerged in recent years, including Indonesia, Malaysia, Pakistan, Singapore and Thailand, while Bangladesh, Myanmar, the Philippines and Vietnam are expected to follow suit.[24]

Even Australia – the world's biggest exporter of LNG – is building import terminals to provide gas to its major cities in the south and east.[25] Most of Australia's gas fields are off the north-west coast, far from the largest populations. Import terminals are quicker and cheaper to build than a pipeline network across the breadth of the country, so imported LNG will be important to Australia's long-term gas price management and security of supply.

As new LNG consumers emerge, demand from existing LNG consumers is expected to increase. In Europe, for instance, LNG is expected to play an increasingly important role. "When you look at the different scenarios in Europe, you see stable demand for natural gas, but declining local production," says Hans Coenen of Gasunie. "This means there is a widening import gap for Europe, which can look to either Russian pipeline gas or LNG for future supply. For geopolitical reasons, LNG will therefore become a bigger part of long-term supply."

In Korea, the world's third-largest importer of LNG, "big LNG import contracts are scheduled to end in a few years and the new government is driving greener energy policy and moving away from coal-fired power plants," says Young-Myung Yang, executive technical advisor (former CTO and head of R&D division) at Korea's KOGAS. "Consequently, LNG players will give more attention to global conventional onshore LNG and FLNG projects to meet increasing natural gas demand."

23 India plans massive natural gas expansion: https://reut.rs/2K2jm3o
24 Asia's new LNG-import markets: http://bit.ly/2usUVpE
25 Australia's LNG export surge fuels domestic supply concerns: https://on.ft.com/2ushScI

Meeting demand growth after 2025

Global LNG export capacity will increase by 45% between 2017 and 2022, with 90% of this capacity coming from projects already sanctioned in the US and Australia.[26] However, there are concerns about supply and infrastructure capacity beyond this point.

According to the Gas Exporting Countries Forum, as much as USD8tn needs to be invested in upstream and gas transportation systems between 2015 and 2040, with upstream expected to account for the bulk of this (USD7.5tn) and the balance to come from liquefaction, regasification, shipping and pipeline projects.[27]

In DNV GL's 2019 Industry Outlook Survey, 43% of senior oil and gas professionals said they believed demand for gas would exceed supply within five years. This was especially the case among respondents from Asia Pacific (61%).

There was more optimism evident in our survey of LNG-focused oil and gas professionals: here, 57% believed global LNG supply will be able to meet China's predicted demand growth in the years to 2025.

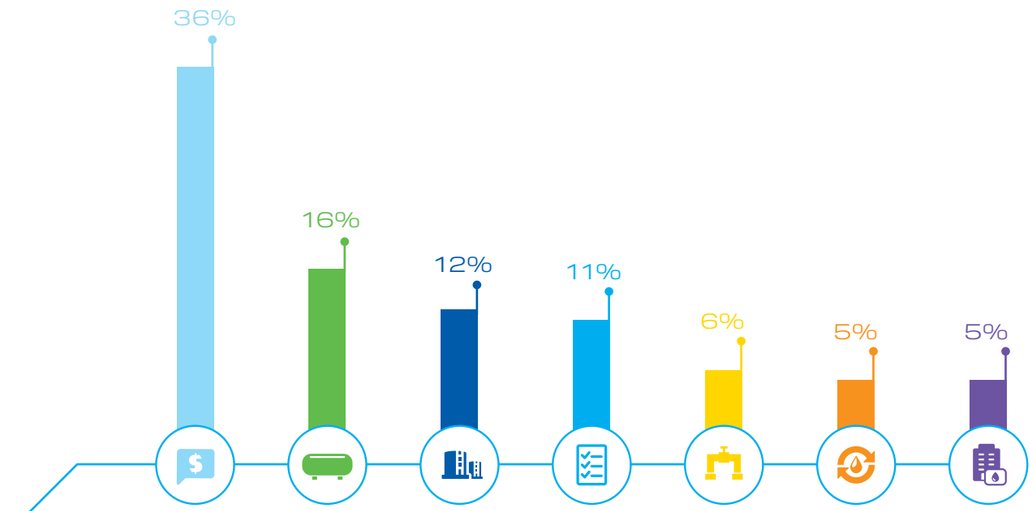
However, the same group was almost universally concerned about the infrastructure investment needed to satisfy expected demand beyond that point: 85% believe several new LNG infrastructure projects will need to be initiated in 2019 to ensure supply can meet demand after 2025.

Eirik Wærness, senior vice president and chief economist of Norwegian multinational energy company Equinor, shares this view: "We need more final investment decisions on new LNG projects globally to avoid having a very tight gas market when we get into the mid-2020s, even though the market right now is well supplied."

26 GECF Global Gas Outlook 2040: http://bit.ly/2OpAuTI
27 GECF Global Gas Outlook 2040: http://bit.ly/2OpAuTI

The growth of LNG depends on the development of infrastructure, particularly facilities to re-gasify, store, and distribute new liquefaction capacity. Our LNG survey respondents believe the cost of financing new facilities (36%) will be the top infrastructure barrier to impact the global LNG market in 2019. Interestingly, they also believe that a lack of LNG refueling and bunkering facilities will become important, ranking this as the second highest infrastructure barrier (16%). Storage facilities – currently a major focus in China – are ranked fourth (12%), just above delays in regulatory approval (11%). Regulatory delays have been a challenge for many regasification projects in nations that are new to the LNG industry.

Top infrastructure barriers for the global LNG market in 2019



Source: DNV GL 2019 LNG Market Survey

- Cost of financing new LNG infrastructure
- Lack of refuelling and bunkering infrastructure
- Lack of LNG/natural gas storage facilities
- Delays in regulatory approval
- Lack of feed gas pipelines
- Bottlenecks at liquification facilities
- Bottlenecks at regasification facilities

LNG: Fueling shipping

LNG demand will also come from its use as a shipping fuel, particularly following new rules set by the International Maritime Organization for 2020 and beyond that require the use of cleaner fuels.[28]

DNV GL's 2018 Energy Transition Outlook projects maritime demand for LNG as fuel to grow from around 16 mt/yr in 2017 to 85 mt/yr in 2050.

More than a third (36%) of respondents to the DNV GL 2019 Industry Outlook survey said their organizations will increase investment in gas-focused projects and portfolios during 2019.

The growing importance of LNG as a transportation fuel was the second-highest-ranked driver for this spending, after the longer-term energy transition.

28 New rules on ship emissions herald sea change for oil market: https://reut.rs/2HDMUGX

Bridging divergent interests

With so much infrastructure needed to meet global LNG demand over the coming years, it is significant that seven in ten (69%) senior oil and gas professionals believe price uncertainty is limiting investments in LNG mega-projects.

Oil-indexed LNG pricing is part of the issue. Recent oil price swings have made LNG sellers reluctant to peg decades-long contracts to volatile crude markets.[29] At the same time, sellers still need long-term commitments to make their infrastructure investments viable.

In our LNG survey, we found opinions divided on the future of oil-indexed LNG pricing. Half (49%) expect contracted LNG prices to continue to be linked to oil prices, while a significant proportion (30%) disagree.

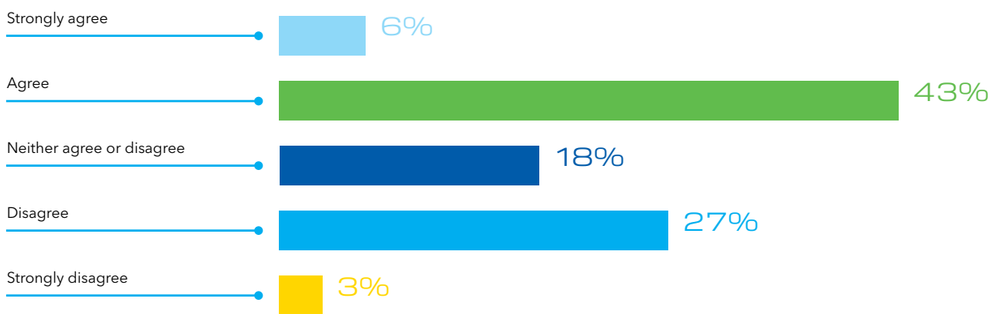
As an alternative to oil-indexation, long-term contracts could be linked to gas-hub prices or even consumer-price indices. However, a deeper issue underlies this: a fundamental disconnect between LNG seller and buyer interests.

Sellers need long-term cashflow certainty to support major investments. Buyers, in contrast, need long-term flexibility to ensure consistently competitive prices, as well as the ability to adapt volumes and contract tenure to market changes.

These needs are not completely compatible – both sides cannot achieve their ideal terms simultaneously – so buyers and sellers must choose where to compromise, and work creatively on new contracting models that help mitigate risk on both sides.

New contractual terms are indeed emerging as the market diversifies, and our research suggests more innovation is required in this regard: nearly three-quarters (72%) of our survey respondents believe LNG buyers need more flexibility in LNG contracts (e.g. to reduce volumes, shorten tenures, and change delivery locations).

Extent to which respondents agree that contracted LNG prices will continue to be linked to the oil price



Source: DNV GL 2019 LNG Market Survey

29 Oil's volatility hastening decline in oil-indexed LNG pricing http://bit.ly/2TyrNr8

The increased importance of portfolio players

Along with new contractual arrangements, the involvement of new market actors could be key to bridging the divergent interests of LNG buyers and sellers.

LNG portfolio players are one example. Such organizations supply LNG from a portfolio of LNG interests from various regions. They often also own (or invest in) shipping, storage, and regasification infrastructure. Portfolio players have an intermediary role between producers and consumers of LNG, and this helps maintain a floor for prices (suiting sellers), while adding market flexibility and liquidity (suiting buyers).

Historically, certain oil majors (e.g. Total, PETRONAS, BP and Shell) have been the most significant portfolio players. However, commodity traders – such as Trafigura, Vitol, Gunvor and Glencore – are now emerging as a significant new breed. In 2017, these four traded around 27 mt of LNG, amounting to 9% of total LNG sold worldwide.[30]

"In the past, international and national oil companies led the global LNG market, but it has now been diversified. New players with new business models (mainly based in North America) are entering the LNG market and changing the market structure and price dynamics," says Young-Myung Yang of KOGAS. Portfolio players are also expanding the scope of their involvements in LNG markets, by entering mid-to-long-term supply positions and investing more in LNG infrastructure.[31]

But according to the International Energy Agency (IEA) , traditional long-term contracts – oil-indexed or otherwise – will also persist. In 2018, for example, Chinese buyers alone signed up for around 10 mt/pa in long-term contracts. The IEA also expects other established buyers such as Japan, South Korea, and Taiwan to continue to source gas via long-term contracts.[32]

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Young-Myung Yang, Yang, executive technical adviser, former CTO and head of R&D division, KOGAS

Simply put, we are seeing the LNG market diversify like never before – both in terms of contractual frameworks and market participants – and it looks likely that multiple models will continue to develop to meet the varied needs of LNG buyers and sellers around the world.

Forces beyond markets

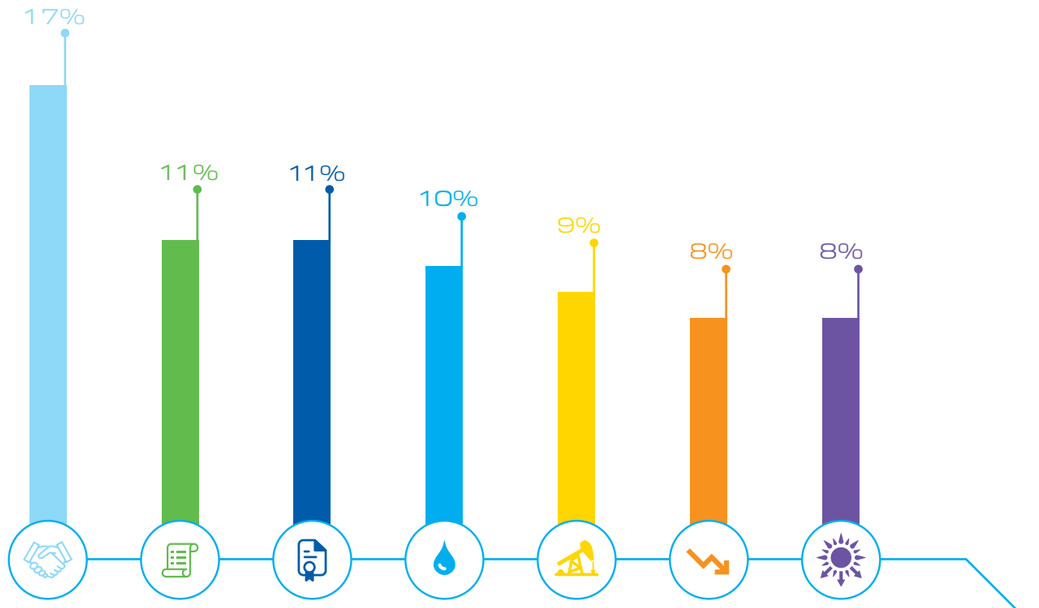
In our survey, political risk (including trade agreements) was expected to be the leading market barrier (17%) to LNG markets in 2019. Young-Myung Yang of KOGAS echoes this view, saying: "Internationally, the main barrier we see is political instability, and protective trade policies from the US and other economies."

There was little global consensus around the next-ranking barriers, though at a regional level we did see some clearer trends. For example, in North America, fear of oversupply was ranked at the top (19%), while in Asia Pacific, difficulties establishing long-term supply contracts shared first place with political/trade risks (18%). In Europe, a lack of government support and public sentiment against fossil fuels were jointly the second-ranked barriers (14%), just behind political/trade risks (16%).

It is revealing that these three major regions can have such contrasting views on the market barriers ahead for 2019. While those in North America wonder if the world can possibly consume the unprecedented volume of LNG set for production, those in Asia are worried about securing long-term supply. In Europe, influencers outside the market top concerns.

30 How four trading houses are shaking up the LNG industry: http://bit.ly/2Oo8pMs
31 How four trading houses are shaking up the LNG industry: http://bit.ly/2Oo8pMs
32 February: Signposts for the gas outlook: http://bit.ly/2Tvs8dZ

Top market barriers for the global LNG sector in 2019



Source: DNV GL 2019 LNG Market Survey

- Political risk / trade agreements
- Difficulties establishing long-term supply contracts
- Not enough government policy support
- Cost competitiveness with liquid fuels (e.g diesel)
- Public sentiment against fossil fuels
- Imported LNG not competitive with local gas markets
- Cost competitiveness with renewable energy sources

Commoditized LNG on the global stage

The LNG market has shifted gas closer than ever to the profile of a traditional commodity. The flexibility, diversity, and responsiveness of global supplies can help markets hedge – and adapt to – political or trade-related developments.

At the same time, with so many interconnected markets in play, events that impact regional gas markets may trigger the same kind of global economic turmoil as oil price shocks of the past (as we saw for example with the 2002 political crisis in Venezuela, the 2003 Iraq war, and the 2010 Arab uprisings).

"I definitely see the geopolitical aspects of the market playing a larger role in the future than they have in the past for gas," says Hans Coenen of Gasunie. "Energy and politics are always connected, but it seems to be playing an even bigger role in the debate."

"I definitely see the geopolitical aspects of the market playing a larger role in the future than they have in the past for gas."

Hans Coenen, vice president, corporate business development, Gasunie

This bigger role on the world stage is yet another dimension to the evolution of LNG markets. It looks set to drive the rise of the global LNG era alongside other important factors, such as the globalization and commoditization of LNG, and innovations in LNG technology and business models.

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As the technical advisor to the oil and gas industry, we bring a broader view to complex business and technology risks in global and local markets. Providing a neutral ground for industry cooperation, we create and share knowledge with our customers, setting standards for technology development and implementation. From project initiation to decommissioning, our independent experts enable companies to make the right choices.

For more information on:
DNV GL's Energy Transition Outlook, visit: eto.dnvgl.com