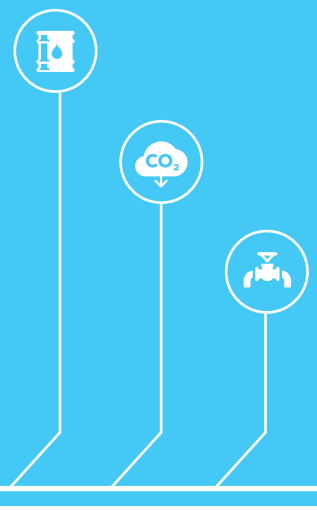
DNV·GL

TRANSITION IN MOTION

How the oil and gas industry is adapting to the long-term energy transition



In this report, we showcase key findings from DNV GL's 2018 Oil and Gas Industry Outlook research and 2017 Energy Transition Outlook. These include the following insights:

- The evolution of the global energy mix is gaining pace as less carbon-intensive sources build momentum. More than four in 10 senior oil and gas professionals (44%) say their organization is now actively preparing for a transition to a less carbon-intensive energy mix.
- Within the energy transition, confidence in the case for gas is increasing. Nearly nine in 10 professionals (86%) believe that gas will become an increasingly important component of the global energy mix over the next 10 years – up from 77% a year ago.
- About two-thirds (64%) say their organization is increasing or sustaining its investment in gas projects in 2018, with gas forecast to overtake oil and become the world's largest energy source by the mid-2030s.

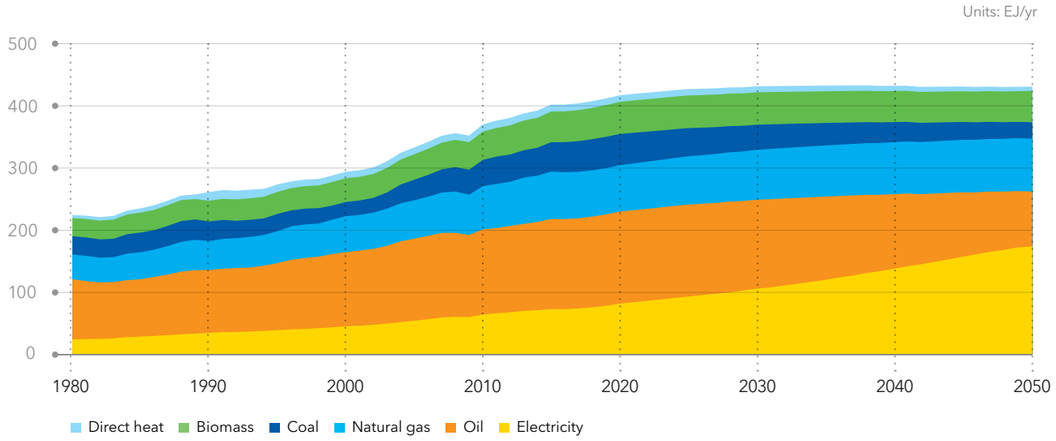
Oil and gas will remain crucial components of the global energy mix over the coming decades, according to several leading energy forecasts, including DNV GL's Energy Transition Outlook. However, the two fuels will take significantly different paths forward as government, business and society take greater steps to lower carbon emissions.

The 2017 edition of our Energy Transition Outlook, which forecasts the global energy mix to 2050, predicts that global oil demand will plateau over the coming 15 years, peaking in the early 2020s. Meanwhile, global gas demand will grow for another two decades, peaking in the mid-2030s. By then, gas demand will be around 15% greater than it was in 2017, and gas will have overtaken oil to become the world's largest energy source.[1]

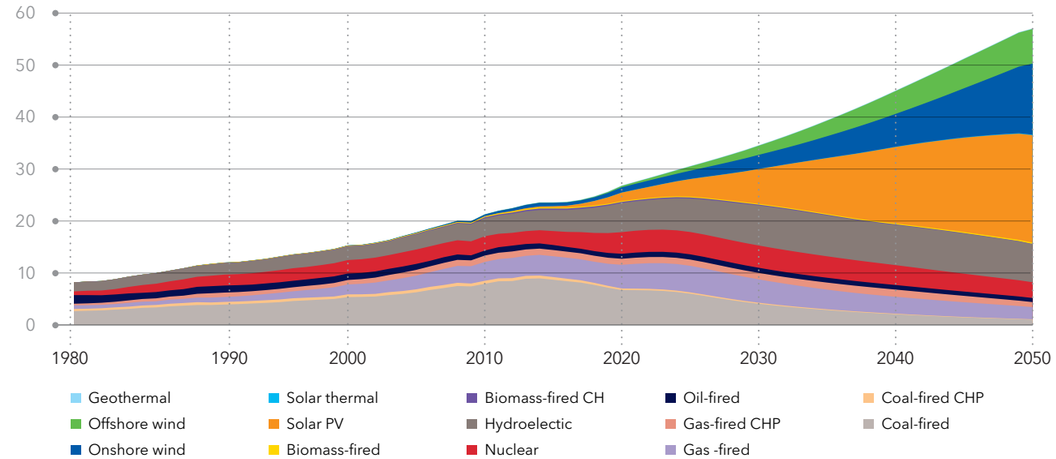
This significant shift is a key part of a wider energy transition. Over the next three decades, much of the world's transport and heat will be electrified, the use of renewable energy such as wind and solar will scale up (see figure 1), green gases (such as hydrogen and biogas) will help to decarbonize gas systems, coal and oil will gradually decline, and new technologies will continue to increase energy efficiency and control greenhouse gas emissions. Where are we today in this energy transition? And to what extent is the oil and gas industry already adapting to it?

1 'Energy transition outlook 2017, Oil and gas forecast to 2050' – DNV GL, September 2017: http://bit.ly/2K8OmlB

Figure 1: The global energy mix to 2050
World final energy demand by energy carrier



World electricity generation by power station type



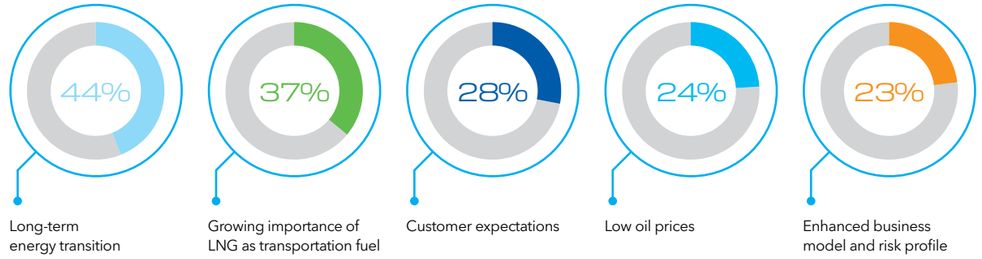
The energy transition gains pace

In DNV GL's 2018 Industry Outlook research, 44% of the 813 senior oil and gas professionals we surveyed say their organization is actively preparing for a transition to a less carbon-intensive energy mix. The sector is also convinced of the case for gas, with the vast majority (86%) agreeing that gas will become an increasingly important component of the global energy mix over the next 10 years – up from 77% in 2017.

Confidence about the future of gas is being met with investment. Nearly two-thirds (64%) say that their company is either increasing (29%) or sustaining (35%) their investment in gas projects in 2018. Just 8% are planning to decrease gas project spending.[2]

2 The rest either don't know (11%) or have no existing or planned investments in gas projects (18%).

Figure 2: Drivers of investment
Top five drivers for investment in natural gas and/or LNG in 2018



Gas in the transition: power and mobility

Our 2017 Energy Transition Outlook forecasts that power generation will be the primary use of gas in most regions, although manufacturing could demand similar volumes in emerging markets such as the Indian Subcontinent and China.

"Gas benefits from being a cleaner power source than other fossil fuels, and with reliable supply and affordable costs we expect solid growth of gas the next 15 years," says Sverre Alvik, programme director for Energy Transition Outlook, DNV GL. "After peaking in the mid-2030s, gas use in power is expected to decline from around 2040, by when wind and solar will dominate power supply."

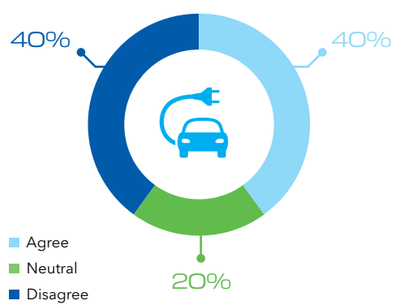
While demand for gas has already peaked in Europe (2010), and will do so by 2020 in North America, many regions – such as China and South-East Asia – will only peak in the mid-2030s. "Emissions regulations will be the biggest factor driving the natural gas and LNG markets in Asia," says Kidong Kim, senior research engineer at Korea's KOGAS research and development (R&D) Institute. "Citizens are aware of how diseases and deaths are caused by serious air pollution. This has increased resistance to coal thermal power plants and diesel-powered transport, including ships. We expect natural gas or LNG to replace these energy sources."

The gradual decline in the use of petrol and diesel for transport will weaken the attractiveness of investments in these fuels. "We see an increasing focus on battery electric light vehicles," says Mark Gainsborough, executive vice president, New Energies, Shell. "The costs are coming down, but they would have to come down a lot further to be fully competitive with internal combustion engines."

Gainsborough is right, but costs are falling quickly. Already, premium, high-performance electric cars are, in general, just 10% more expensive than equivalent internal combustion models.[3] At the lower end of the market, electric vehicles still cost 50% more, but are expected to be cheaper than petrol vehicles by as early as 2025.

According to our Energy Transition Outlook, 1.1 million electric cars were sold in 2017; 13 million are expected to sell in 2025, 40 million in 2030, and 110 million in 2040. By then, 55% of all vehicles sold will be electric.[4] The senior oil and gas professionals participating in our survey are evenly divided on the extent to which they think electric vehicles will, or will not, reduce global oil consumption over the next decade; 40% fall into either camp, while 20% are neutral.

Figure 3: Electric vehicles versus oil
Extent to which respondents agree that electric vehicles will significantly reduce global oil consumption in the next decade.



3 Electric cars becoming cheaper – Drive: http://bit.ly/2tbOnLY

4 Electric Vehicle Outlook 2018 – Bloomberg New Energy Finance: http://bit.ly/2K6yYpD

Some forms of transport cannot easily be electrified, so heavy vehicles such as ships, trucks, and aircraft will instead be a growing source of LNG demand. According to our Energy Transition Outlook, gas will be used for around 30% of all transport energy use in 2050.

> "We see the future for cost-effective and low-carbon power generation as renewables plus gas, that's something that is in the money now and needs to be built out pretty rapidly."
>
> **Mark Gainsborough,** executive vice president, New Energies, Shell

In transport, as in power generation, gas is the energy-transition fossil fuel best-positioned to cover capacity and applications for which zero-carbon technologies are not yet viable. "We see the future for cost-effective and low-carbon power generation as renewables plus gas," says Gainsborough. "That's something that is in the money now and needs to be built out pretty rapidly."

Upstream: growing supply for growing demand

National oil companies and supermajors are investing in large-scale natural gas and LNG projects all over the globe, and projected reserves are ample for even the slowest transition to renewable energy sources (provided they continue to be developed in good time).[5]

Across the giant territories of Canada, Russia, the US, and Australia, multiple major projects are adding to global gas supply, alongside the continuous development of massive fields in Iran, Egypt, Qatar, the United Arab Emirates, and Saudi Arabia.

For instance, Chevron announced in April that it will proceed with the second stage of the Gorgon LNG project offshore Western Australia. Drilling of 11 new wells in the Gorgon and Jansz-Io fields is expected to begin in 2019, ensuring that the massive project – one of the world's largest natural gas developments – will maintain its target production rate of 15.6 million tons of LNG per year.[6]

There are also globally significant projects in development from relatively new supply regions in Central Asia and Africa. For example, off the coast of Mozambique, development is under way on Africa's first floating LNG (FLNG) facility: the Coral South LNG project, which is estimated to hold over 450 billion cubic metres of gas. This is an advanced project in a part of Africa that has not seen much large-scale oil and gas development, but if it can remain on schedule, it is forecast to produce 3.4 million tons of gas per year from 2022.[7]

Our Energy Transition Outlook forecasts that the most sustained gas production will come from two regions: North East Eurasia and the Middle East and North Africa. Production is also forecast to rise in Asia, with gas output from China and the Indian Subcontinent expected to more than double by 2050. Gas production in North America, meanwhile, currently the world's largest gas producer, will plateau at current levels for the next decade, and European gas production will decline.

"In Asia, gas is showing the most rapid growth of all energy sources," says Kim. "The speed and efficiency of supply is increasing due to the development of new technologies such as small-scale LNG and FLNG."

In meeting demand for gas, the upstream sector is benefiting from the increased returns and greater agility built over recent years, from both technological advances and new cost efficiencies. Offshore development and production costs have fallen by between 30% and 40% in the past three years thanks to supply-chain efficiencies, increased standardization, and new developments in drilling and well design.[8]

> "The speed and efficiency of supply is increasing due to the development of new technologies such as small-scale LNG and FLNG."
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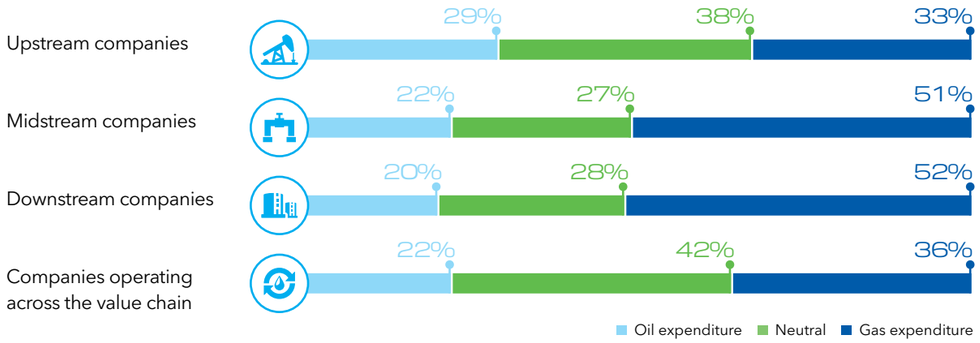
> **Kidong Kim,** senior research engineer, KOGAS research and development (R&D) Institute

At the same time, as Kim points out, the advent of FLNG and small-scale LNG projects are allowing for the continued new development of offshore gas, including remote locations and previously unviable 'small pools' and 'stranded fields'. Most companies seem to be keen to make further use of their agility: 61% of upstream respondents to our Industry Outlook survey say that their organization will favour investments in projects that are adaptable within shorter timeframes.

5 Our Energy Transition Outlook estimates gas reserves to be 530 trillion cubic metres (Tm3), of which around a third (180Tm3) is identified, proven conventional reserves, and 350Tm3 are other gas resources, such as unconventional and hwydrate sources.
6 Chevron Australia advances Gorgon LNG project – Oil & Gas Journal: http://bit.ly/2yq4PNz
7 Africa's First Floating Gas Facility Will Charge Up Mozambique's Economy – General Electric: https://invent.ge/2tp2Cw0 & http://bit.ly/2tcAjS8
8 'Energy transition outlook 2017, Oil and gas forecast to 2050' – DNV GL, September 2017: http://bit.ly/2K8OmlB

Figure 4: The investment balance – oil versus gas



Midstream: connecting new sources of gas

As the use and importance of gas grows, midstream companies are busy rolling out infrastructure to connect new sources of supply with changing demand centres while maintaining older pipeline infrastructure.

More than 276,000 km of onshore pipelines will be installed globally between 2017 and 2021.[9] Based on our Industry Outlook research, the Middle East and North Africa region expects the most significant increase in both onshore and offshore pipeline investment over the next three years, but major projects are in progress across the world.

Many of these are gas pipelines, and this reflects the shifting emphasis towards gas. In 2013, for instance, 61% of all planned pipeline construction was for crude oil and products. Of the 23,588 km planned for 2018, over 80% are gas pipelines.[10]

This includes some mega projects that will have a major impact on the future energy mix. For example, the 3,000 km "Power of Siberia" line that is being built as part of a USD400 billion contract between Russia's Gazprom and the China National Petroleum Corporation to deliver 38Gm3/yr of Russian gas to China from late 2019.[11] The 3,500 km Southern Gas Corridor, meanwhile, is a series of pipelines that will connect gas from Azerbaijan to markets in Europe via Turkey. Alongside LNG imports and new fields in Northern Europe – such as the Equinor (formerly Statoil) Aasta Hansteen project[12] – this pipeline is intended to support greater competition and security in the European gas market.[13]

Simultaneously, investment in LNG projects is surging: currently, there is enough export capacity in development to increase LNG from 33% to 40% of total global gas trade by 2022. This rapid increase in share will happen alongside a strong growth in piped natural gas around the world.[14]

The rapid rise of LNG is driving up LNG tanker traffic and the development of port and regasification facilities. In April 2018, for the first time ever, three LNG tankers passed through the Panama Canal in a single day.[15] Seaborne gas trade from North America to China will grow from 30Gm3/yr in 2017 to more than 85Gm3/yr by the mid-2020s, according to our 2017 Energy Transition Outlook forecast. By as early as 2020, the Panama Canal is expected to carry five times the volume of LNG it carried in 2017.[16]

According to Business Monitor International, transport of gas as LNG is expected to exceed pipeline transportation by 2035. Globally, our Energy Transition Outlook predicts a near-continuous 3% per annum increase in seaborne LNG trade, from 282 metric tonnes per annum (Mtpa) today, to 660Mtpa in 2050. Much of this traffic will be in the direction of countries that currently have less well-established gas infrastructure, such as China and India, which will demand unprecedented investment in LNG port and processing facilities.

For example, India's government plans to build 11 LNG import terminals over the next seven years (in addition to the four already in place). This is part of a strategic and significant shift to gas, which will see India increase its gas use from 6.5% of its energy mix today to 15% by 2020.[17] Our Energy Transition Outlook, meanwhile, forecasts that China will be the region with the most significant increase in gas imports over the next 10 years.

9 'The world onshore pipelines market forecast 2017–2021', Douglas-Westwood, December 2016
10 Near-term pipeline plans – Oil & Gas Journal: http://bit.ly/2K8smag
11 The Power of Serbia – Gazprom: http://bit.ly/2l4fihn
12 Norway Reports Record Gas Sales - OilPrice.com: http://bit.ly/2tkEYRr
13 Southern Gas Corridor – Trans Adriatic Pipeline: http://bit.ly/2tn0qW4
14 Boom in American LNG – The New York Times: https://nyti.ms/2K2yBcs
15 A First for Panama Canal – Bloomberg: https://bloom.bg/2JZSlgN
16 Panama Canal to carry 30 million tonnes of LNG by 2020 as global demand grows – Reuters: https://reut.rs/2tcg4nS
17 India plans massive natural gas expansion – Reuters: https://reut.rs/2K2jm3o

Many other countries are building the facilities they need to import LNG. As recently as 2005, only 15 countries imported it. That number has more than tripled since, with major economies such as Pakistan, Thailand, Jordan, Egypt, Poland, and Colombia joining the buying market in recent years. At present, Bahrain, Bangladesh, Ghana, Haiti, Namibia, Panama, the Philippines, and Uruguay are all building import terminals.[18]

Downstream: refining a complex mix

The longer-term energy transition and the rise of gas create both complexities and opportunities for the downstream oil and gas industry.

Globally, our model forecasts a shift in the refinery industry's feed mix from 60% oil/34% gas today to around 56% oil/40% gas in 2050 – another indication of the increasing importance of gas and the gradual reduction in oil consumption.

At the same time, however, we expect a fall of around 30% in production levels over the same period, driven by regional transitions in feedstock supply and product demand.[19] In addition to these shifts in refining supply and demand, the increasing complexity of the fuel mix, consumer demand, and government regulations will mean that downstream companies need to continuously evolve during the energy transition period.

For instance, in our Industry Outlook research, more downstream organizations than upstream and midstream companies reported an intention to diversify in 2018. Some 65% of downstream respondents say they are likely to invest in opportunities outside of fossil fuels this year, but still within energy. These opportunities include renewable energy generation, electric vehicle charging networks, biofuel synthesis, and hydrogen.

At the same time, there are examples of upstream-focused companies making major investments in downstream businesses – particularly in the Middle East. For example, in May 2018, the Abu Dhabi National Oil Company announced a USD45 billion investment to expand its refining and petrochemicals industry.[20]

With large downstream businesses in their portfolios, integrated oil company respondents also reported intentions to diversify. "We're playing across a fairly wide space in the new energies territory because I think we see a wide range of opportunities going forwards," says Shell's Mark Gainsborough.

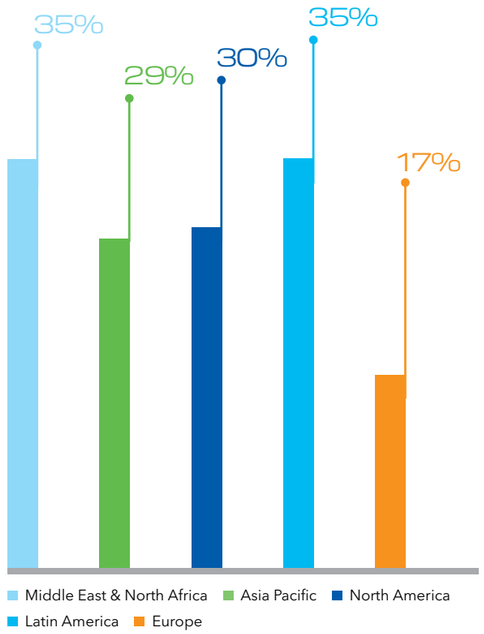
"Blending more biofuels is something that we believe will be an important feature in the coming years and Shell is a very active participant in the biofuels business."

Mark Gainsborough, executive vice president, New Energies, Shell

This suggests that for those with downstream businesses, the energy transition is about much more than gas versus oil. "In transportation, for example, even with the rise of electric vehicles, we see internal combustion engines being used for long time, and one of the best ways to decarbonize these engines is to blend biofuels," says Gainsborough. "Blending more biofuels is something that we believe will be an important feature in the coming years, and Shell is a very active participant in the biofuels business."

Figure 5: Coping with changes to the gas mix

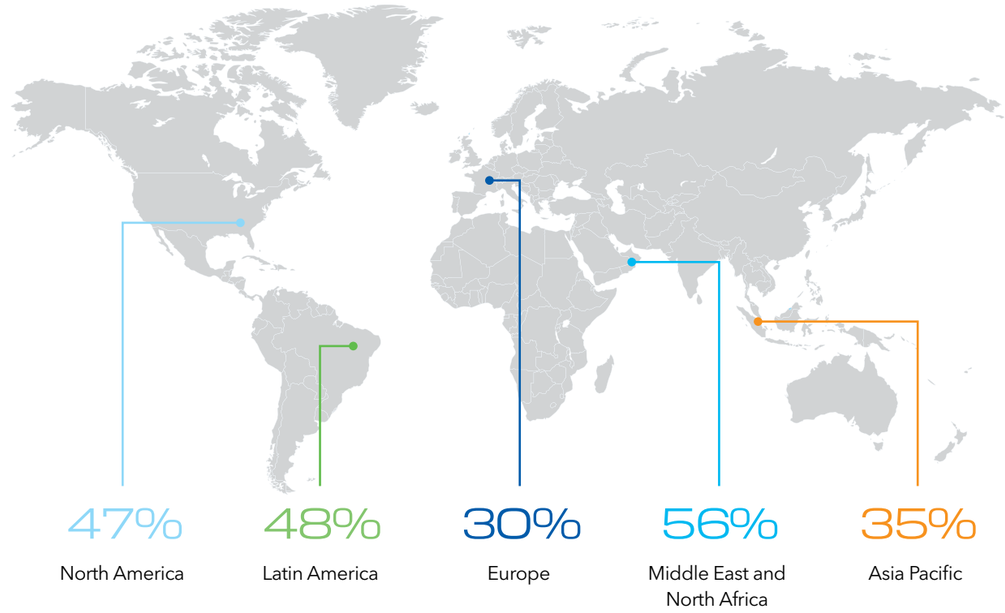
Extent to which respondents think onshore pipeline projects currently in development are adaptable enough to cope with potential long-term changes in the gas mix (e.g. greater variety of calorific values, hydrogen and biogas).



18 Boom in American LNG – The New York Times: https://nyti.ms/2K2yBcs
19 The Indian subcontinent is the only region where we expect refinery production to grow, with petrochemicals output expected to double by 2050.
20 Finacial Times: https://on.ft.com/2K27MVT

Figure 6: Pipeline project approval outlook

Proportion expecting a significant increase in the approval of new oil and gas pipeline projects (offshore and onshore) globally, over the next three years.

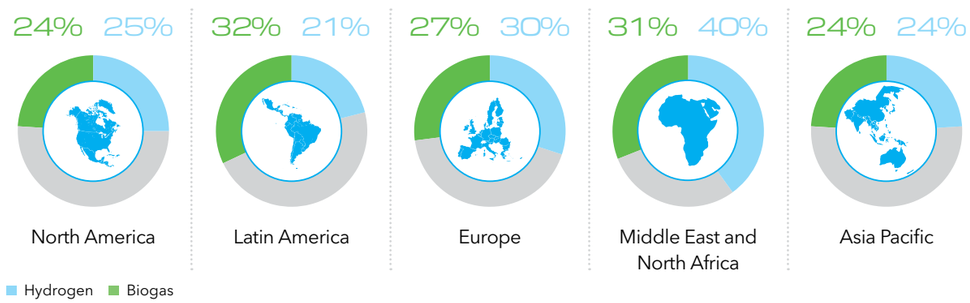


Evolving gas distribution networks

As the energy transition gains pace, gas distribution networks aim to preserve and grow their businesses alongside, and often in direct competition with, low carbon alternatives. Gas networks, such as those operated in the UK, the US and the Netherlands, are realizing the need to demonstrate that their infrastructure can play a key role in the overall decarbonization of energy.

Biogas and hydrogen will be key to these objectives. For example, Northern Gas Networks, the UK gas network operator, has initiated a project which aims to convert the gas grid in the city of Leeds from natural gas to zero-carbon hydrogen. DNV GL is a primary partner in this initiative, which will demonstrate the potential hydrogen has to help the UK meet 2050 climate change obligations, while also making use of existing gas network infrastructure.[21]

Figure 7: R&D investment in emerging technologies for decarbonization



21 DNV GL primary project partner in Northern Gas Networks led Hydrogen Network Innovation Project – DNV GL: http://bit.ly/2tbV7cK

Planning for the long-term; agile in the short-term

Over the next two decades, as gas demand matures, hydrogen, wind, solar, biofuels and other new energy technologies will continue to gain momentum. Demand for gas will peak in the mid-2030s, and from that point, the energy transition enters the final phase-out of fossil fuels as primary components of global energy supply.

This is the most likely scenario, considering the known variables, and it highlights the crucial importance of gas in the near- and medium-term.

However, as our Energy Transition Outlook makes clear, there are uncertainties that could change the trajectory of the energy transition, and impact the prospects for gas. The ultimate mix, location and scale of gas transport projects is continuously evolving, while geopolitics and regulatory reforms have the potential to alter many aspects of the supply-demand equations.

There has never been a more crucial time to take a long-term view. For instance, companies that had the foresight to anticipate the demand for LNG – and act on it – now outcompete their rivals in the world's fastest growing energy segment. "If we hadn't had taken a long-term view, we would have never gotten into the LNG business, which took decades to get to the scale it is today," says Gainsborough of Shell. "I suspect it will be the same with the opportunities in the new energy space."

Based on our Industry Outlook survey, just under half the sector in 2018 is actively planning and investing in response to the unfolding energy transition. These companies stand a strong chance of success through the three decades of significant change ahead. By being bold enough to act – to transform their businesses to match a changing world – they increase their chance to beat rivals to the unfolding opportunities, and thrive beyond oil, beyond gas, and into the new energy future.

Look out for the latest DNV GL Energy Transition Outlook in the third quarter of 2018, featuring adjustments and refinements to our forecast based on new data, plus new topics such as energy infrastructure, the role of hydrogen, and the impact of digitalization on the energy transition.

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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:
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