



A TEST OF RESILIENCE

The outlook for the oil and gas industry in 2019

SAFER, SMARTER, GREENER

ABOUT THE RESEARCH

A *test of resilience* is an industry benchmark study on the outlook for the oil and gas industry in 2019. The research is published by DNV GL, the technical advisor to the sector. It was launched in 2011 and is now in its ninth year. Each edition builds on the findings of previous research.

This report assesses industry sentiment, confidence, and priorities, and provides expert analysis of the key challenges facing the industry in the year ahead. It is based on a global survey of 791 senior industry professionals and executives, along with in-depth interviews with a range of experts, business leaders, and analysts. The research was conducted during late October and early November 2018. The research was carried out by teams from DNV GL, Longitude, and Kantar TNS.

The organizations surveyed vary in size: 44% had annual revenue of USD500 million (m) or less, while 17% had annual revenue in excess of USD5 billion (bn).

Respondents were drawn from across the oil and gas value chain, including publicly-listed companies and privately-held firms. They represent a range of functions within the industry, from board-level executives to senior engineers.

The findings and views expressed in the report do not necessarily reflect the views of DNV GL.

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Technology Centre Mongstad

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CEO, Petronas Gas Berhad

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vice president,
DNV GL - Oil & Gas

Hans Coenen,
vice president, corporate
business development, Gasunie

Anthony Green,
head of engineering
and asset management,
National Grid

Liv Hovem,
CEO, DNV GL - Oil & Gas

Cliff Johnson,
president, Pipeline Research
Council International, Inc.
(PRCI)

Frank Ketelaars,
regional manager, Americas,
DNV GL - Oil & Gas

Flemming Horn Nielsen,
operations director,
INEOS Oil & Gas

Thina Saltvedt,
senior advisor, sustainable
finance, Nordea Bank

Nelson Queiroz Tanure,
CEO, PetroRio

Eirik Wærness,
senior vice president and
chief economist, Equinor

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

Yuan Zhengang,
deputy director of Oil & Gas
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01

RESILIENT, CONFIDENT, AND READY TO SPEND

Despite market volatility towards the close of 2018, the oil and gas industry enters 2019 on firm footing with cost-efficiency measures in place across the supply chain. Relatively solid supply and demand fundamentals also support a clear sense of direction for the industry, which appears to be more prepared than ever to take on new challenges.

Indeed, the fresh optimism that we reported one year ago, in DNV GL's 2018 *Industry Outlook*, appears to have grown stronger over the year, reflecting both the resilience of the industry and the potential for new growth opportunities.

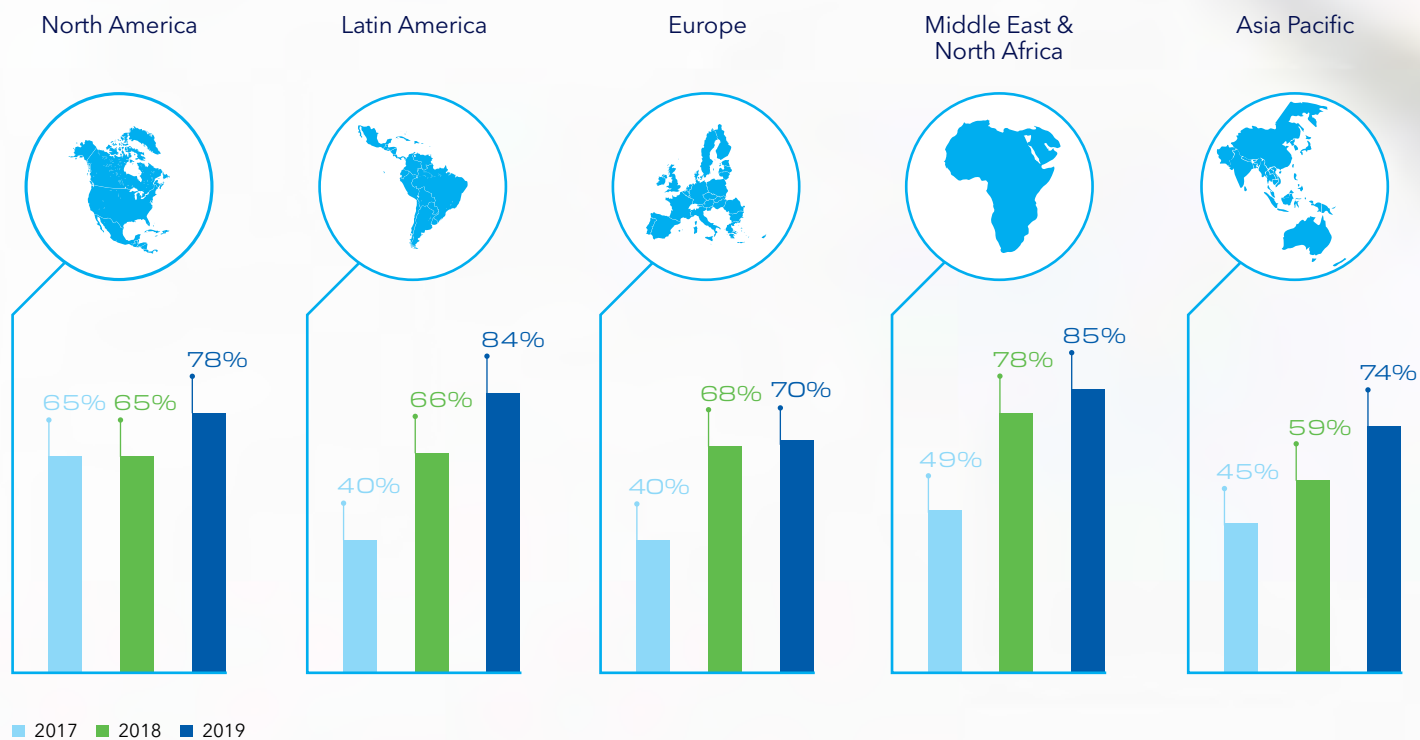
Our survey of senior oil and gas professionals, conducted in the last quarter of 2018, found 76% of senior oil and gas professionals confident about the industry's growth prospects for 2019. This is a sizeable step up from 63% a year ago, and more than double the levels recorded in 2016 and 2017. Respondents in Brazil (95%), China (89%) and the US (85%) are the most optimistic for 2019.

Three-quarters of global respondents (74%) are also enthusiastic about the prospects for their own organizations in 2019, up from two-thirds (66%) in 2018. This is similarly reflected in the confidence that respondents have in hitting both their revenue (69%) and profit (62%) targets. Each of these measures are 8 percentage points higher than in 2018.

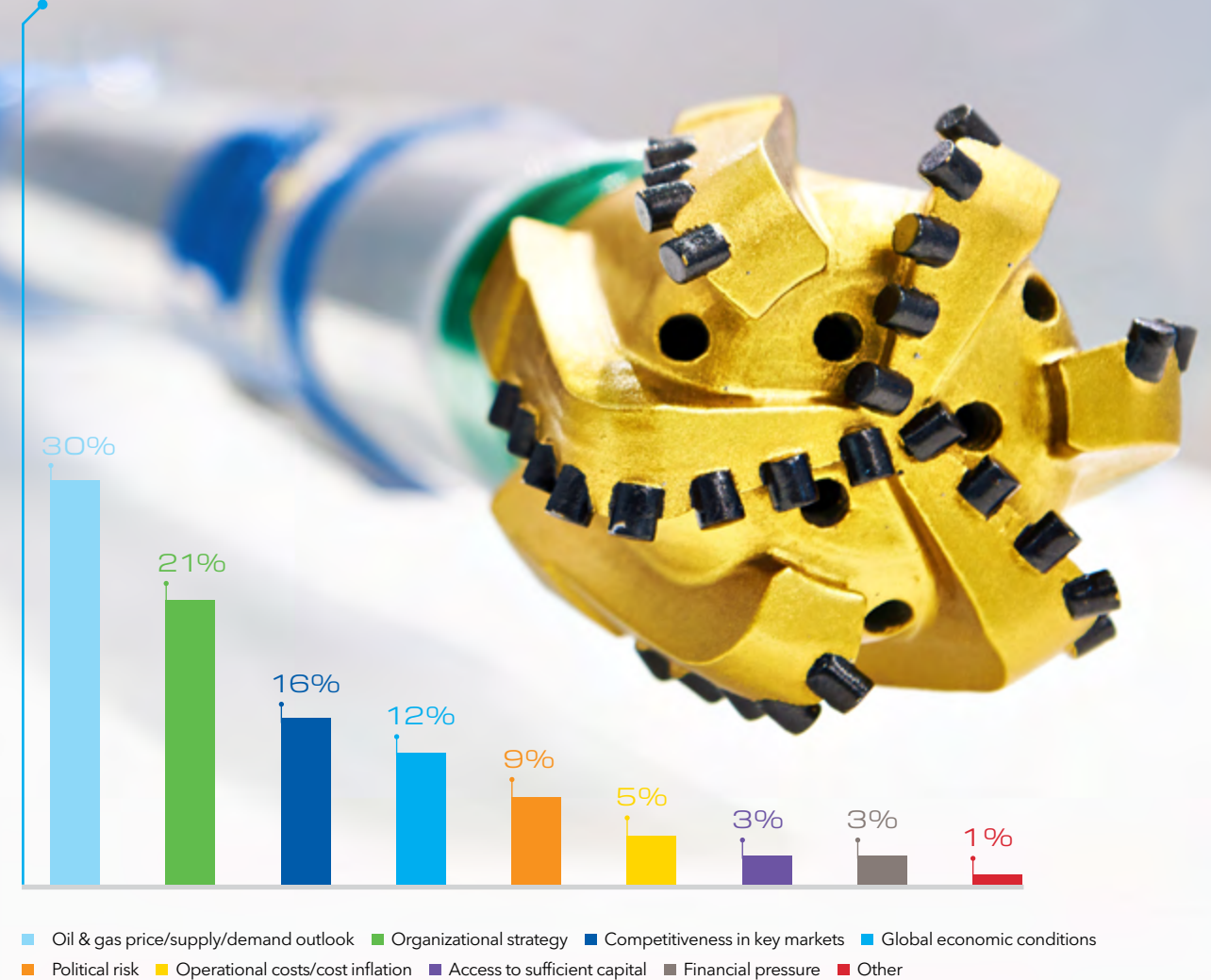
"What happened over the last two months of 2018 was a very clear signal to the industry that volatility is something that we should expect"

Eirik Wærness, senior vice president and chief economist, Equinor

Development in respondents' optimism about the prospects for their organizations



Factors driving profit confidence in 2019



Long term industry confidence is also rising

Looking beyond 2019, a clear majority (57%) of respondents to our survey believe that oil and gas companies will be able to achieve high profitability over the next decade - a large rise from 45% a year ago. Levels of optimism differ by region, but the overall trajectory is the same.

In Asia Pacific, sentiment around prospects for the decade ahead rose dramatically, up from only 34% in 2018 to 56% in 2019. Similarly, the majority of respondents based in the Middle East and North Africa (53%) are now optimistic, compared to 39% in 2018. Respondents from Europe also saw an uptick in optimism, albeit smaller, with 55% expecting the industry to achieve high profitability in the next decade, relative to 48% in 2018.

These high levels of confidence for both 2019 and the coming decade suggest that the industry believes in its ability to adapt - to both higher volatility in the short term and shifts in supply and demand patterns in the longer term.

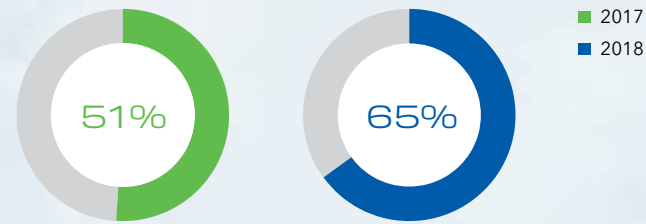
An industry ready to weather volatility

After a largely stable oil price over the first three quarters of 2018, in November fears around oversupply spooked traders.¹ Rising inventories in the US, and uncertainty about intended production levels from OPEC countries and Russia, seemed to drive the sharp fall in prices.² Concerns about a global economic slowdown in 2019, as well as the impact of political turmoil and trade disputes, also contributed to a renewed sense of uncertainty.³

Both the West Texas Intermediate (WTI) and Brent Crude benchmarks dropped by more than 20% in November 2018, making it the weakest November in over a decade.⁴ This quickly revived some of the industry and market angst we saw between 2014 and 2016.

For example, the Cboe Global Markets Crude Oil ETF Volatility Index (OVX), which tracks levels of volatility in the oil market, showed a sharp uptick in November and December 2018, returning to levels not seen since the most tumultuous years of the downturn.⁵

Extent to which respondents agree that their organization's prospects have improved over the past year



Eirik Wærness, senior vice president and chief economist of Norwegian multinational energy company Equinor, says the first 10 months of 2018 were characterized by a perception of relatively good underlying fundamentals. "Then the market perception changed, even though the fundamentals had not changed too much. What happened over the last two months of 2018 was a very clear signal to the industry that volatility is something that we should expect."

Flemming Horn Nielsen, operations director for INEOS Oil & Gas Denmark, does not expect recent volatility to have a major impact on the industry's investment plans for 2019 and beyond. "The industry is always planning with a long-term forecast for oil prices, and I don't think companies took the last quarter of 2018 as indicative of the price to come," he says. "What is more important than current volatility is understanding the long-term level we can expect."

High enough prices

Despite the sharp falls in oil price in late 2018, the average for the whole year was approximately USD70 per barrel, compared with an average of approximately USD50 per barrel for 2015, 2016, and 2017.⁶

Our research shows a close correlation between our measure of industry confidence - tracked over the past nine years by this survey - and the oil price. While still highly correlated, we have seen confidence rise at a faster rate than the oil price in the past two years. This may be partly driven by enthusiasm around a long-awaited return to growth.

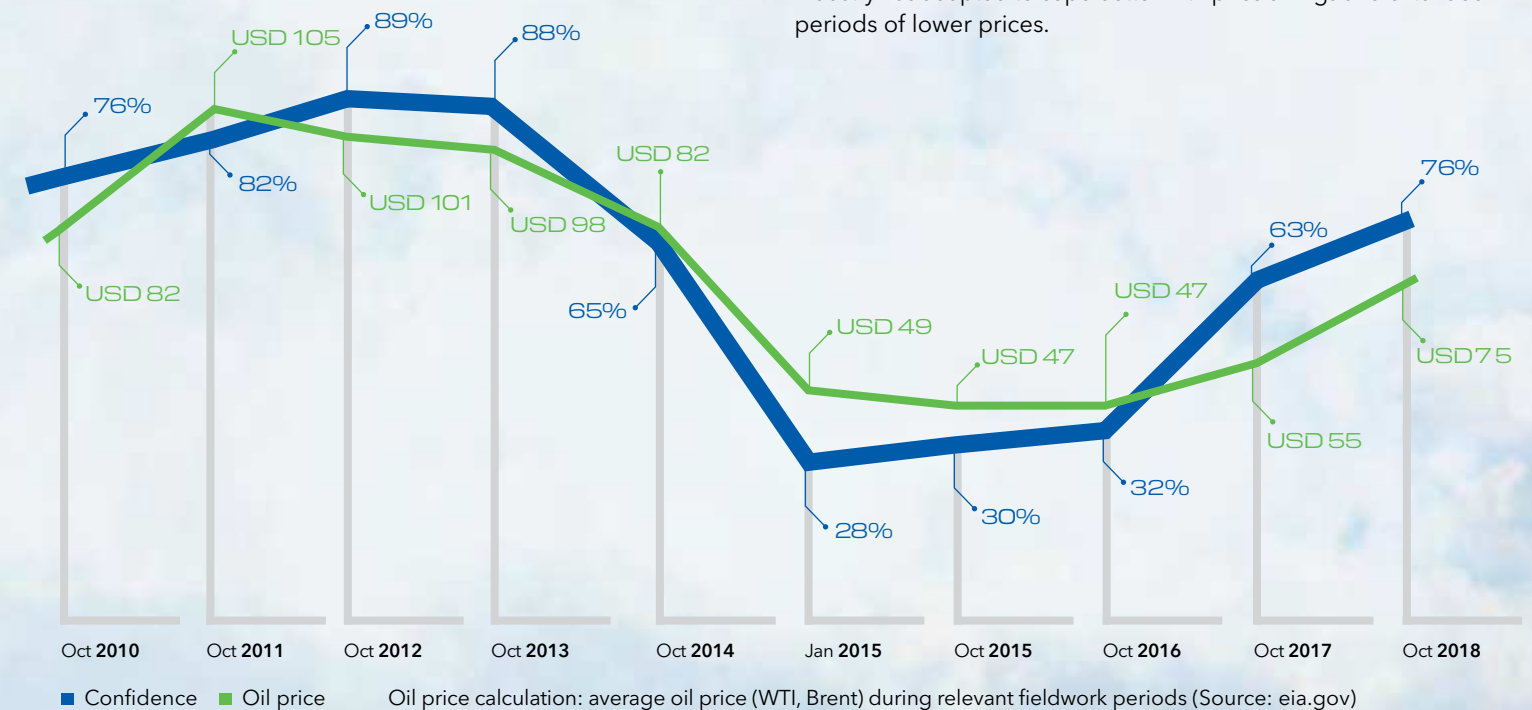
"I don't think companies took the last quarter of 2018 as indicative of the price to come"

Flemming Horn Nielsen, operations director, INEOS Oil & Gas Denmark

Natural gas is also growing in importance and operators are increasingly focusing on expanding their portfolios in this sector with the expectation that gas will overtake oil to become the world's primary energy course in the years to come. Nevertheless, natural gas prices remain largely pegged to oil benchmarks via long-term off-take contracts (with the exception of the US Henry Hub and the UK's NBP benchmarks) and are therefore still largely correlated with industry confidence about oil.

The rise in confidence, particularly in the face of recent market volatility, also signals newfound resilience and indicates that the industry has adapted to cope better with price swings and extended periods of lower prices.

Oil price vs. overall industry confidence



1. Financial Times: <https://on.ft.com/2TRopbv>
 2. Oil curbs gains amid trade, output cut uncertainty - Reuters: <https://reut.rs/2VRnqKg>
 3. Financial Times: <https://on.ft.com/2SR5FCP>
 4. Oil prices fall, set for more than 20 percent loss in November: <https://cnb.cx/2QKBaCE>

5. The Cboe Crude Oil ETF Volatility Index measures the market's expectation of 30-day volatility of crude oil prices: <http://bit.ly/2DS0OQU>
 6. Brent Crude Oil Prices - 10 Year Daily Chart | MacroTrends: <http://bit.ly/2RoKwsZ>

Ready to spend

Encouraging results in 2018, and a greater sense of resilience among senior oil and gas professionals for the year ahead, appear likely to herald the return of greater investments in the industry.

Two-thirds (67%) of respondents to our survey say that more large, capital-intensive oil and gas projects will be approved in 2019 than in 2018. For many industry participants, a standout example of what might come was the multi-billion-dollar final investment decision (FID) in October for the LNG Canada project in British Columbia, a joint venture between Shell, PETRONAS, PetroChina and others.⁷

Confidence in the future growth of the gas market is also sparking investment activity among industry participants. While prices still move together today, the anticipated global expansion of liquid natural gas (LNG) trade in the coming decade may see the natural gas price increasingly decouple from its peg to oil,⁸ while exports from the US may lift the decade-long depression of the US Henry Hub gas benchmark that followed the onset of shale gas production.⁹

Final investment decisions for gas projects have also picked up pace in Australia. Chevron gave the green light to invest USD5.1bn in an expansion of the Gorgon project in April 2018,¹⁰ and in December ExxonMobil committed to the West Barracouta gas project.¹¹

More FIDs are expected to maintain the country's LNG capacity for export and domestic use. For example, in October 2018, Australian independent oil and gas company Woodside awarded a front-end engineering and design contract to Bechtel to advance a second LNG train at Pluto LNG on the Burrup Peninsula, with FID slated for 2020.¹²

Predicted growth in gas demand is also driving midstream infrastructure projects, including several LNG mega projects such as the fourth LNG train in Qatar and two LNG trains at the Rovuma Basin in Mozambique.¹³

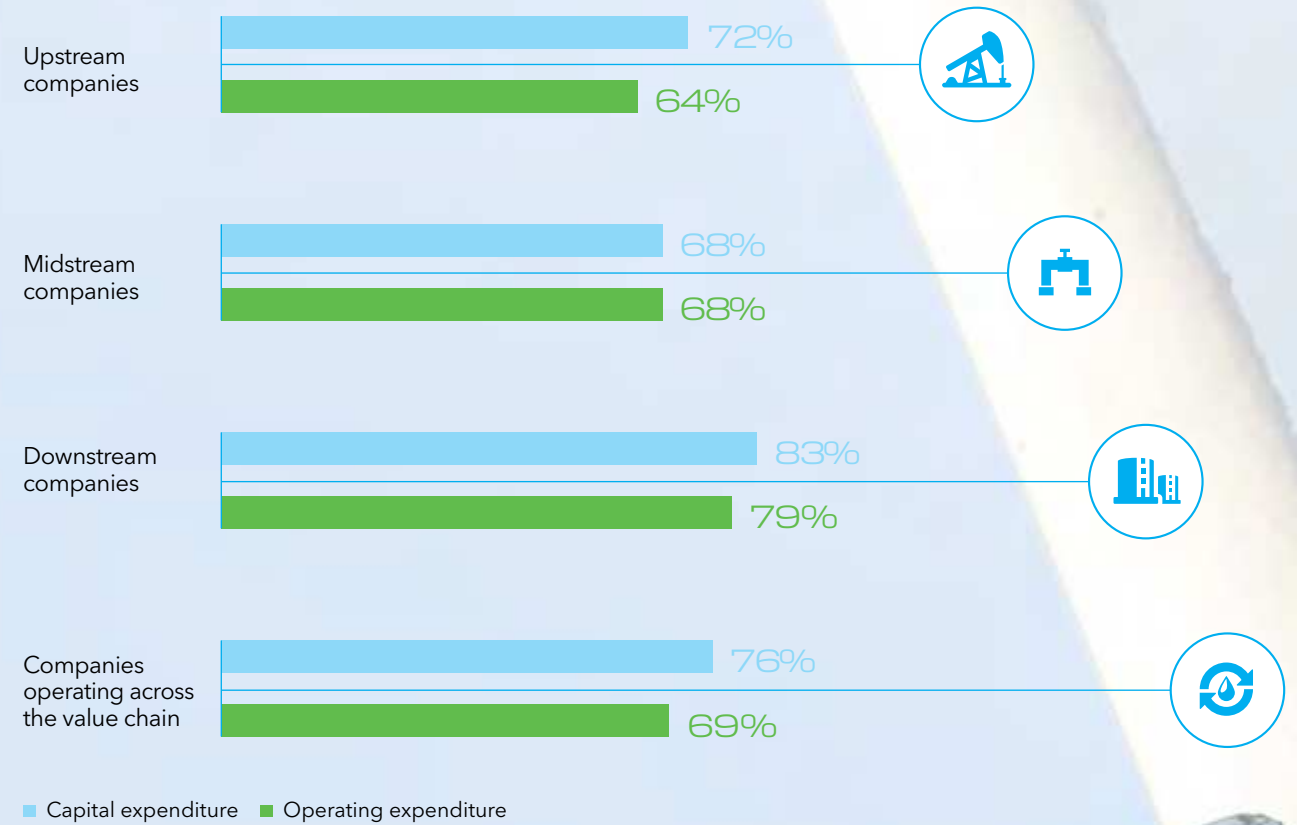
In the Middle East, gas extraction is also ramping up, but as the world's biggest oil producer the region continues to draw investment in oil. Abu Dhabi National Oil Company (ADNOC) announced a large spending programme of USD132bn between 2019 and 2023 to boost oil production, and develop the country's gas resources and associated downstream segments. The latter will see an allocation of USD45bn to expand the Ruwais petrochemicals complex.¹⁴

Meanwhile, Brazilian national oil company Petrobras announced a five-year plan that allocates USD68.8bn to its exploration and production business, and USD8.2bn to downstream operations.¹⁵

Our survey shows that 70% of senior oil and gas professionals are looking either to maintain or increase capital expenditure (capex) in 2019, up from 66% in 2018, and just 39% in 2017. Around two-thirds (65%) plan to maintain or increase operating expenditure (opex), also showing a sharp upward trajectory from 2018 (58%) and 2017 (41%) results.

This shows that oil and gas companies aim to keep up any investment and expansion strategies put in place over the past year. However, signs of cost inflation in the supply chain could be a reason for caution, as we will see in the next section.

Percentage of respondents who expect to maintain or increase capital and operating expenditure in 2019, by sector



7. Shell gives green light to invest in LNG Canada - Shell Global: <https://go.shell.com/2RtQtF8>
 8. Commentary: Oil prices have gone up and it may affect your electricity bill - Channel NewsAsia: <http://bit.ly/2RPqasm>
 9. U.S. LNG exports could bump domestic natural gas prices: <http://bit.ly/2TPFTVp>

10. Chevron to give go-ahead for \$5.1 billion stage two of Gorgon gas project off the Pilbara coast | The West Australian: <http://bit.ly/2M9Hldh>
 11. ExxonMobil Makes Final Investment Decision to Develop West Barracouta Gas Project: <https://exxonmobil.co/2ssh8Di>

12. Woodside picks Bechtel for Pluto LNG train 2 FEED - LNG World News: <http://bit.ly/2D9HfVQ>
 13. New wave of mega LNG projects is approaching - Reuters: <https://reut.rs/2VPuUNG14>
 14. Abu Dhabi approves \$132bn oil and gas investment plan: <http://bit.ly/2RsSukT>
 15. Petrobras to spend \$68.8B on E&P - Offshore Energy Today: <http://bit.ly/2TOFjYa>

02

SPENDING DISCIPLINE SET TO BE TESTED

Capital expenditure per barrel of oil rose by an enormous 10.9% CAGR between 1999 and 2013.¹⁶ This was absorbed by high oil prices through the second half of that era, but when prices tumbled in 2014, companies across the value chain found themselves halting investments and cutting costs at an unprecedented rate.

Thina Saltvedt, senior advisor on sustainable finance at Nordea Bank, a financial services group, points out the transformative impact of cost-efficiency measures. "The oil and gas industry actually makes bigger profits now than they did when the oil price was USD150. This is because of cost control measures implemented after the sharp fall in oil prices in 2014."

But today, overall confidence is at levels last seen in 2011, just prior to the boom and bust cycle of that time. This increasing optimism, coupled with expectations of new capital spending, will test the sector's resolve around the cost efficiency and discipline established over recent years.

The key question is: will companies fall back into inefficient spending habits, or can they maintain their organizational austerity? Our research shows signs that old habits may already be resurfacing.

Focus on cost control

While more than half (54%) of the senior oil and gas professionals we surveyed say the hard-fought cost-efficiency measures put into place during the downturn are permanent, this measure is down from 62% just a year ago.

In addition, 21% of our respondents say cost efficiency will be a "top priority" in 2019, a drop from 31% in 2018, and 41% in 2016.

Elsewhere, the proportion of companies planning to become stricter on cost controls has dropped from a high of 72% in 2015 to 44% for 2019.

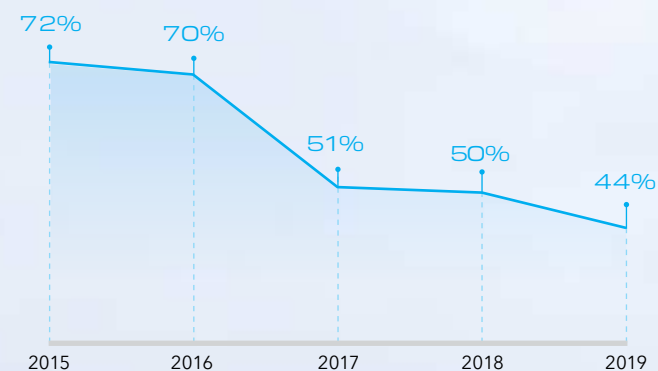
All told, companies may be relaxing their tight grip on costs in 2019, but only modestly so at this stage.

Higher oil prices over the course of 2018 haven't changed the industry's focus on higher net margins. For example, Bob Dudley, CEO of BP, said at the end of November that the company was still working hard to bring down costs and that the business was planning to get its project break-even point down towards USD40 per barrel.¹⁷ He confirmed that BP's spending plans remain largely unchanged, even factoring in November's steep price falls.¹⁸

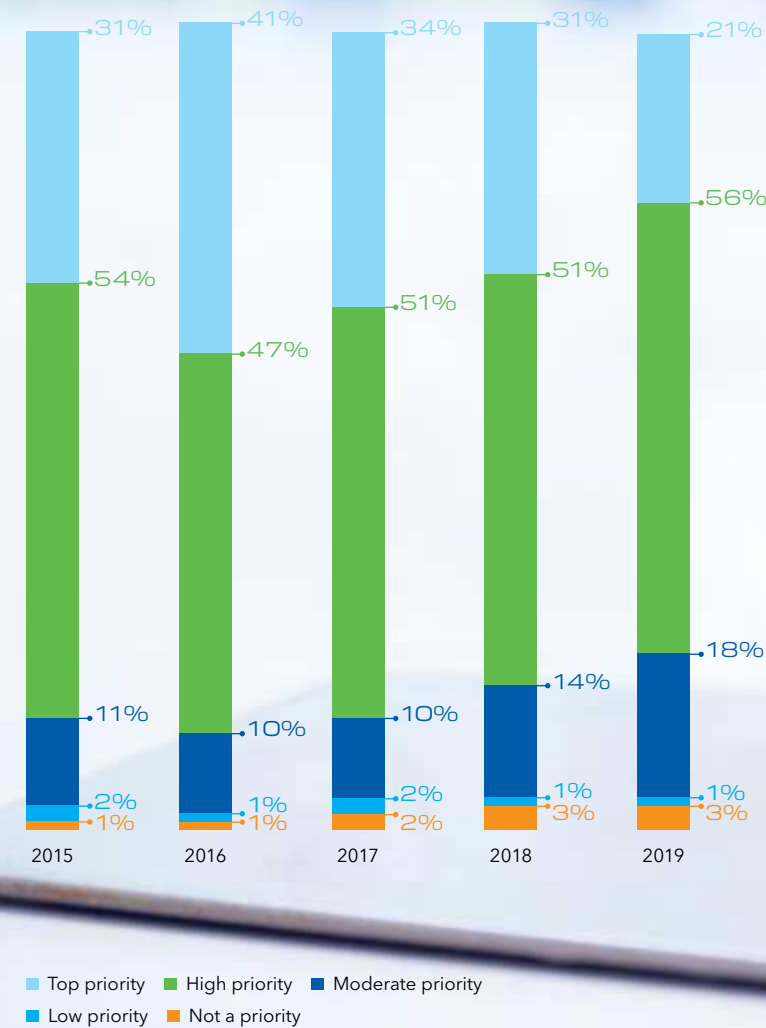
Eirik Wærness, senior vice president and chief economist of Norwegian multinational energy company Equinor, points out that real efficiencies have been introduced into the industry's working patterns: "We have actually changed the way we work, whether that is the way we operate or the way we plan. That has led to much smaller investment requirements for the same number of barrels, with much shorter drilling times. There's no reason to believe that will change significantly. We won't go back to the old ways of working."

For example, the application of new technologies, tried and tested in the US shale boom, is expected to shorten development cycle times for offshore conventional oil projects and reduce costs by 40%-50%.¹⁹

Percentage of respondents who say their company will increase strictness on cost control



Extent to which cost efficiency will be a priority, by year



"We have actually changed the way we work, whether that is the way we operate or the way we plan"

Eirik Wærness, senior vice president and chief economist, Equinor

16. From Capex Growth to Capital Discipline: <http://bit.ly/2VSRnJN>

17. Financial Times: <https://on.ft.com/2TMRUCUX>

18. Equinor won't cut spending despite oil price declines - Kallanish Energy News: <http://bit.ly/2FrGPMW>

19. Oil's Boom-and-Bust Cycle May Be Over. Here's Why: <http://bit.ly/2TS89XN>

Inflation uncertainty

While oil and gas companies do appear intent on remaining cost conscious, it is reasonable to expect some degree of inflationary increase in underlying costs as the market picks up, and demand for products and services increases. Staff reductions had already begun to taper off in late 2016²⁰ and our survey shows that more than a third of oil and gas professionals (34%) expect to increase headcount in 2019.

“Cyclical cost cuts are behind us, and so it will be harder to keep the same cost levels,” warns Equinor’s Wærness. “Now, in this period, in which the industry has to start investing more, there is an underlying danger of a gradual cost creep.”

Our survey respondents agree: 41% said they experienced cost inflation from their suppliers in 2018, rising to more than 50% in the Middle East and North Africa, and in Asia Pacific. Breaking this down by sector, respondents from the downstream are most affected (60%) compared to just over one-third in the upstream (34%).

Indeed, 37% of respondents noted that their organizations’ contracts are exposed to cost inflation, and 40% expect suppliers to drive cost inflation in 2019 – even though 45% think operators

will be able to keep costs under control. Some areas of the industry appear more acutely affected than others. For example, the subsea construction sector, which is rallying again as the industry focuses on developing subsea tiebacks, has the highest level of concern about contracts being exposed to cost inflation (58%).

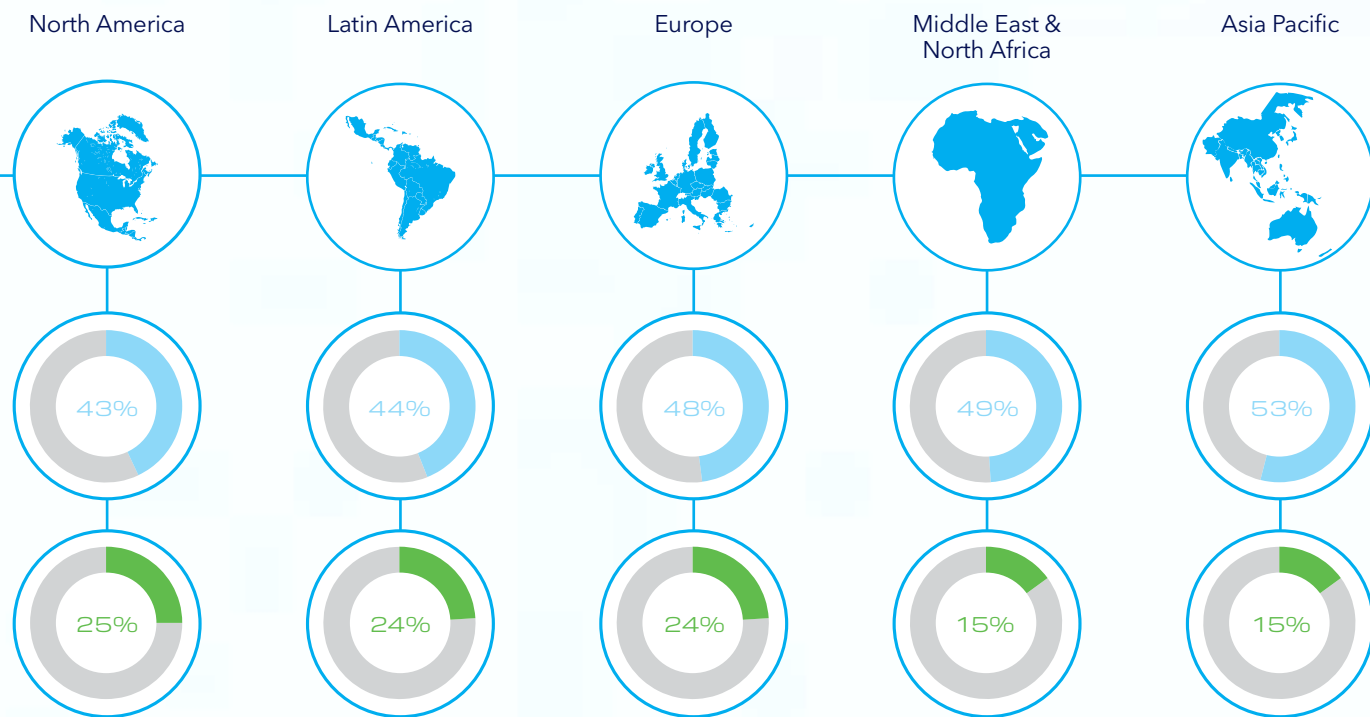
Concerns over skills shortages signal inflation

In what ought to be good news for all, the oil and gas industry’s headcount will be on the rise again in 2019. This is the belief of 34% of those polled for this study, a sharp rise from 20% in 2018, and just 10% at the lowest point of the downturn in 2015.

While a return to hiring is a welcome sign of industry confidence, there will be clear challenges associated with growing headcount after a period of significant cuts.

Skills shortages and an ageing workforce topped our survey respondents’ lists of barriers to growth during every year of the industry’s last boom period (2011-14), when cost inflation was at its highest. When the oil price collapsed, this fell sharply, to tenth place, and has remained low on the industry’s list of concerns ever since.

Companies’ success in achieving their 2018 cost efficiency targets, by region



■ Somewhat successful: made progress towards targets, but did not fully achieve them ■ Highly successful: met or surpassed targets

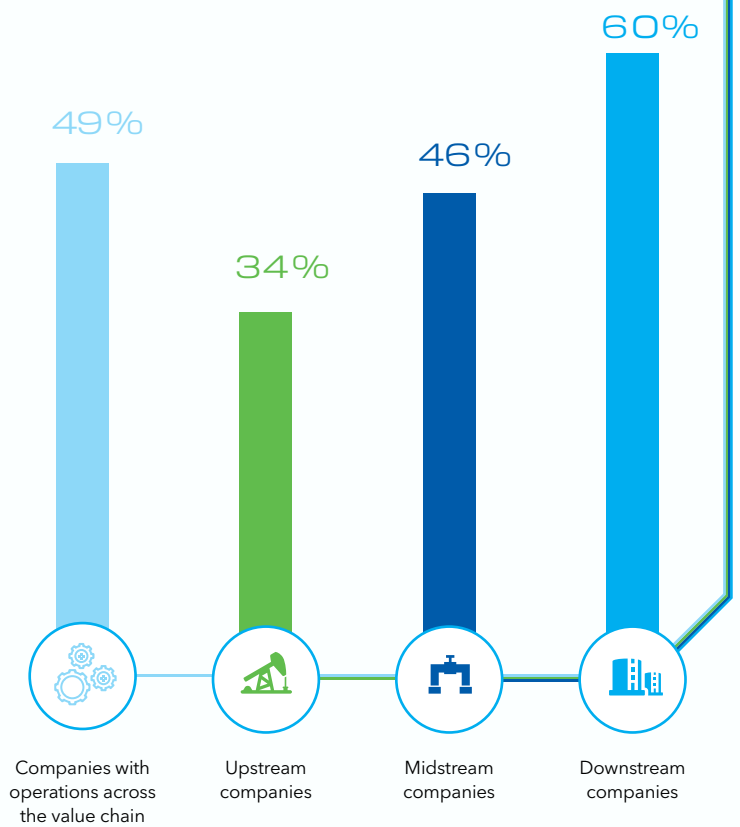
For 2019, skills pressures are now firmly back on the agenda, rising sharply in our survey to take joint second place in the industry’s barriers to growth. This comes alongside concerns about the oil price and the state of the global economy, and just behind the challenge of competitive pressures (see page 17).

This skills gap hits hardest in Europe and North America (both 25%). In the UK, 39% see this issue as the greatest barrier to growth for 2019, the highest of any country. By contrast, concern is lowest in Latin America (10%), and the Middle East and North Africa (15%), despite having local content restrictions in place, while nearly one in five (18%) in Asia Pacific is feeling the squeeze.

Liv Hovem, CEO, DNV GL - Oil & Gas, sees the challenge of recruiting again after one of the industry’s toughest downturns as a significant risk to the oil and gas industry in 2019. “We need to ask ourselves how we expect to attract the talent that will be required to deliver as activity picks up again,” she says. “How easy will it be for us to recruit if the industry is becoming busier? Who would like to join our industry so soon after it dramatically cut so many people?”

The skills gap may be exacerbated by the fact that fewer young people are joining the industry after witnessing a period of stagnation. Many engineers are drawn to jobs in “greener” energy industries, while data scientists – much sought-after following the industry’s increased focus on digitalization – are often drawn to technology firms and other digitally-driven companies.²¹

Percentage of respondents who said their company experienced price inflation in 2018, by sector



20. The Press and Journal (Moray): 2016-09-13 - Light at end of the tunnel as job cuts look set to taper off: <http://bit.ly/2SQpOig>

21. ‘Sexiest Job’ Ignites Talent Wars as Demand for Data Scientists Soars - Fortune: <http://bit.ly/2FxCxST>

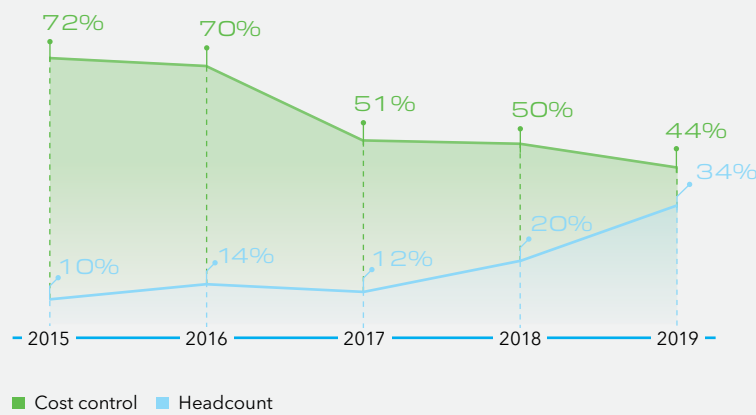
A report from EY highlights that the oil and gas industry suffers from a perception issue in relation to young people, who are disincentivized to pursue careers in oil and gas by concerns about the longevity of the industry and a perceived harmfulness to society²². According to EY's survey, 62% of Generation Z (ages 16-19) find the prospect of a career in oil and gas "unappealing," while 44% of millennials (ages 20-35) say careers in the industry do not appeal to them.

DNV GL's Hovem believes that it is vital to help young engineers understand the role that the oil and gas industry will play in decarbonizing the world's energy system. "Decarbonization will become a prevailing theme of the oil and gas industry over the coming decades. Those working in our industry will have an incredible opportunity to influence that trend," she says.

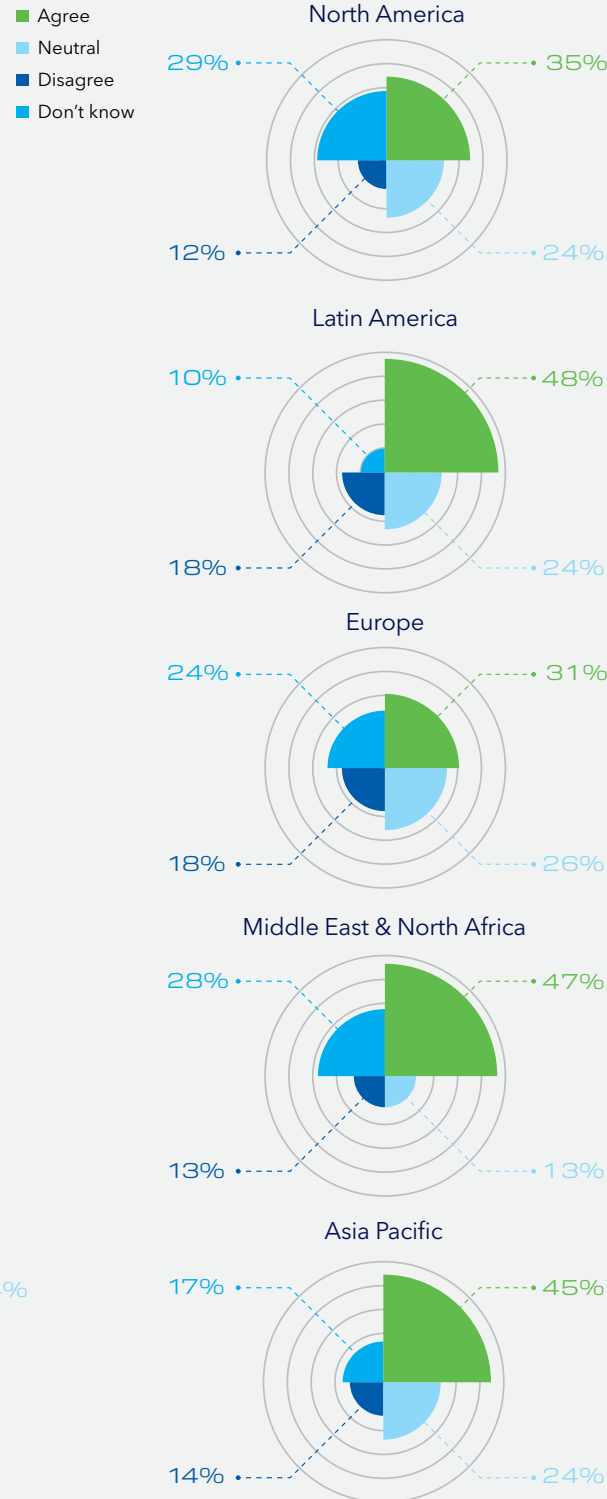
Another means of attracting talent lies in highlighting the vast scale of the technological and engineering challenges to be overcome, as experts such as Rice University's Kenneth Medlock have highlighted.²³ He says students enter his courses each year imagining the oil and gas industry as it was a hundred years ago. To engage younger generations, Medlock advocates a focus on today's technological challenges: producing "greater quantities of oil and gas from more complex geologies, all while increasing environmental stewardship."

Cliff Johnson, president of Pipeline Research Council International (PCRI), also argues that the industry's digital transformation will be attractive to young talent: "How do you use artificial intelligence? How do you use big data? How do you use all this information? A lot of new technologies and new ideas still need to be found for our industry, as mature as it is. There's still a lot of creativity and opportunity for a young workforce."

Proportion increasing headcount vs. proportion increasing cost control



My organization's contracts are exposed to cost inflation as a result of the recent recovery in oil price



Barriers to growth in 2019

Competitive pressure now ranks as the biggest expected barrier globally in 2019, unseating the price of oil, which has topped the list of worries for the past five years. These top two issues are closely followed by the global economy, skills shortages, and an ageing workforce.

At a regional level, the picture is rather more varied:

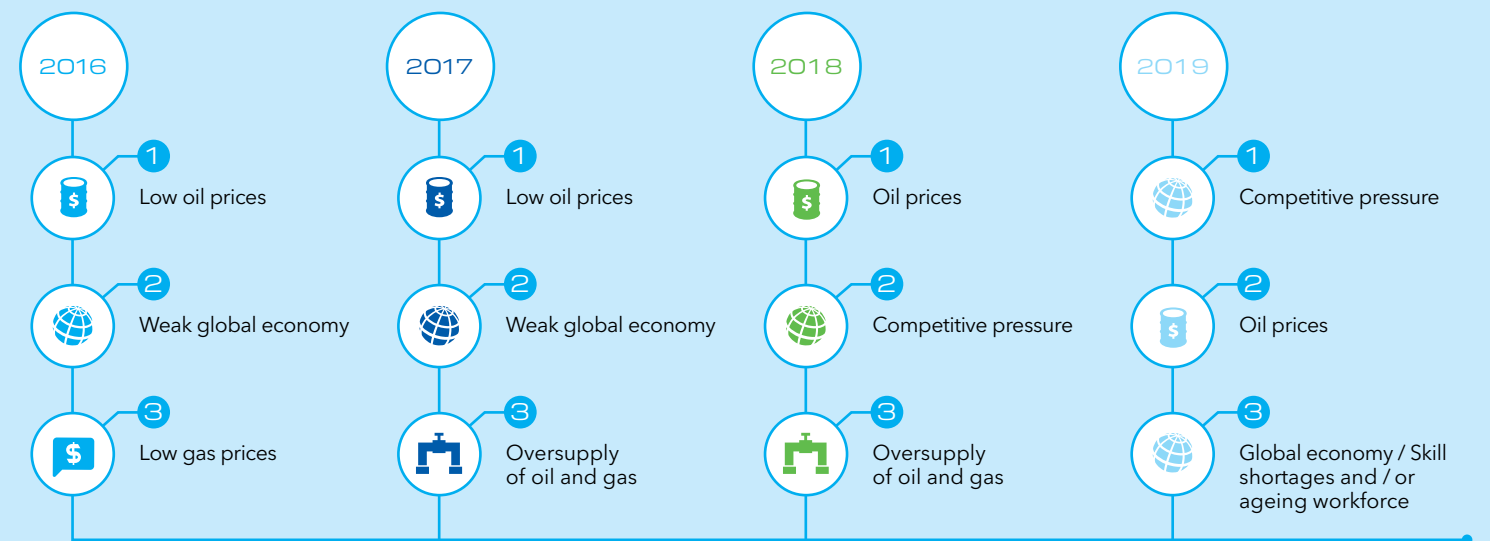
- The global economy is the primary concern in Asia Pacific, where an escalating debate over US-China trade tariffs has spread bearish sentiment across several industries. "Domestically, the main concerns for us are economic recession and the variability of government policy," says Young-Myung Yang, executive technical advisor (former CTO and head of R&D division) at Korea's KOGAS. "Internationally, the main barrier we see is political instability and protective trade policies from the US and other economies."
- In the Middle East and North Africa region, the oil price and operating costs top the list of concerns. This is an interesting development, as the region includes countries that have some of the lowest oil-production costs in the world, including Saudi Arabia, Iraq and Iran.²⁴ Costs such as raw materials and labour now appear to be rising at a time when the US has eroded much of the control these nations had - via OPEC - over global oil markets. Political instability and conflict in the region are also closely associated with oil price uncertainty. In our survey, respondents from the Middle East and North Africa enter 2019 as the most likely to increase cost control, increase opex, and give highest overall priority to cost efficiency.

- Competitive pressure and skills shortages are the leading barriers in Europe. Meanwhile, North America is the only region in which skills shortages are the leading barrier. Renewed concerns about a shortage of skills could in turn deliver a return to the cost inflation that the industry has worked to keep down over the past five years. Following a period of staff reductions during the downturn, head-hunters and recruitment agencies are now returning to the market. Operators are also trying to entice skilled workers away from the supply chain with higher salaries, which is an additional driver for cost inflation.
- The local economy tops the list of barriers in Latin America, given the weaknesses in countries such as Venezuela. However, regime changes in the continent's two largest economies, Mexico and Brazil, are expected to be a benefit for the oil and gas industry. Mexico's new president, Andrés Manuel López Obrador, has said he is looking to increase oil production, and in December announced an investment of USD8bn for 2019 to boost the country's refining sector.²⁵ Meanwhile, the Brazilian government held two successful rounds of auctions for its deepwater pre-salt blocks in 2018, with another round announced for 2019, offering more than 40 new exploration blocks.²⁶

"The new government has said all the right things when it comes to auctioning off new blocks, as well as eventually correcting or improving existing regulation. So, as a whole, in Brazil there is positive sentiment"

Nelson Queiroz Tanure, CEO, PetroRio

Top three barriers to growth, by year 2016-2019



22. How do we regenerate this generation's view of oil and gas?: <https://go.ey.com/2Ru6dHY>
 23. Millennials, Oil And Gas And The "Energy Transition": <http://bit.ly/2Fr77yE>

24. Barrel Breakdown - WSJ.com: <http://bit.ly/2TNfyY8>
 25. Lopez Obrador Says Mexico to Build an \$8 Billion Refinery - Oil & Gas 360: <http://bit.ly/2HIMVQm>
 26. Brazil Council Approves Sixth Round Pre-salt Auction - AOG Digital: <http://bit.ly/2FwfDM1>

03

PRESSURE BUILDS IN THE OIL AND GAS SUPPLY CHAIN

As the wider oil and gas industry comes to grips with a more volatile oil price environment, parts of the supply chain are still trying to adjust to recent market dynamics. The cost reductions made during the downturn may be unsustainable in the long term, especially amid a rising demand for services.

Our survey suggests there will also be a rise in service outsourcing - with 39% of senior oil and gas professionals expecting to increase use of contractors - while growing availability of capex is fuelling final investment decisions and driving demand for services.

In turn, companies that identified themselves as predominantly suppliers of services are more likely to increase headcount than those buying services (39% compared to 24%). This resourcing drive is likely in response to (or in the hope of) new contracts. Oil services company Archer, for example, was seeking to expand its workforce on the Norwegian Continental Shelf by 30% by the end of 2018, following the signing of a major drilling services contract.²⁷ Similar plans for staff growth have been reported across a range of other services companies, including Trican Well Service and RPC in Canada,²⁸ and Starn Group²⁹ and PD&MS³⁰ in Scotland.

Despite the prospect of suppliers hiring more people to work on more projects in 2019, they are still feeling the pinch. Suppliers are much less confident of achieving their revenue (66%) and profit targets (57%) in 2019 than buyers (82% and 80%, respectively), according to our survey.

Frank Ketelaars, regional manager, the Americas at DNV GL - Oil & Gas, says that the supply chain remains under a lot of pressure, both onshore and offshore. "The oil companies have made very good profits this year. But in the supply chain, most companies have probably not increased their rates for the past four years. At some stage, the supply chain will have to get at least inflationary increases in prices for the system to be sustainable."

Thina Saltvedt, senior advisor for sustainable finance at Nordea Bank, sees the supply chain squeeze as a symptom of the market's rebalancing after a tough few years, in which all parties were affected. "Oil companies will have lower costs, not only because they managed to change their working strategy, but also because the tight cyclical costs have been cut sharply. The services industry will start to charge more now that the market is in balance, but it doesn't seem like they are 100% there yet. It will probably take one to two years before we will see that increase again," she says.

Percentage of respondents planning to increase headcount in 2019

■ Service buyers
■ Service providers



"The services industry will start to charge more now that the market is in balance, but it doesn't seem like it is 100% there yet"

Thina Saltvedt, senior advisor, sustainable finance, Nordea Bank

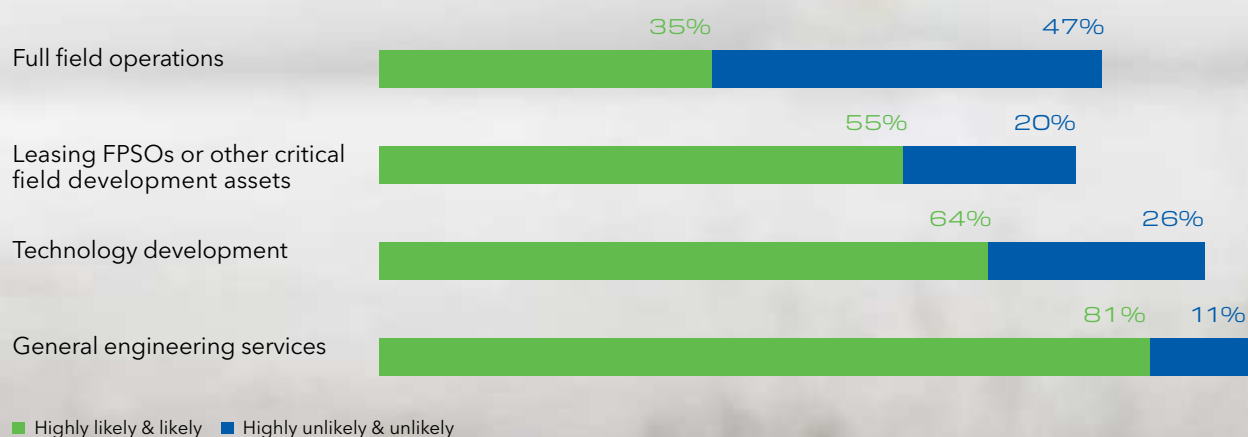
Consolidation calls again

Some suppliers are unlikely to be able to wait for the market to rebalance itself in a year or two. Rather, further consolidation is on the horizon for the oil and gas supply chain, according to our survey. Two-thirds of service suppliers (66%) believe that consolidation will increase in 2019, as will 64% of buyers, making it one of the few measures that respondents from both sides are largely aligned on.

One recent example was offshore drilling company Transocean's deal to acquire ultra-deepwater specialist Ocean Rig, which gave Transocean access to a skilled workforce, new technologies, several drill-ships and other key operational assets.³¹ Crucially though, the deal is expected to result in USD70m saved in annual cost synergies. This kind of vertical integration effectively makes an easy handshake out of what could become a tense arm wrestle over price inflation and profit sharing.

In our survey, mergers in the supply chain are most likely in the Asia Pacific (74%), and the Middle East and North Africa (72%) regions, where the vast majority expect increased consolidation in 2019. In Malaysia, PETRONAS has become active in encouraging consolidation to address overcapacity, stating that it will award contracts to larger players with economies of scale.³²

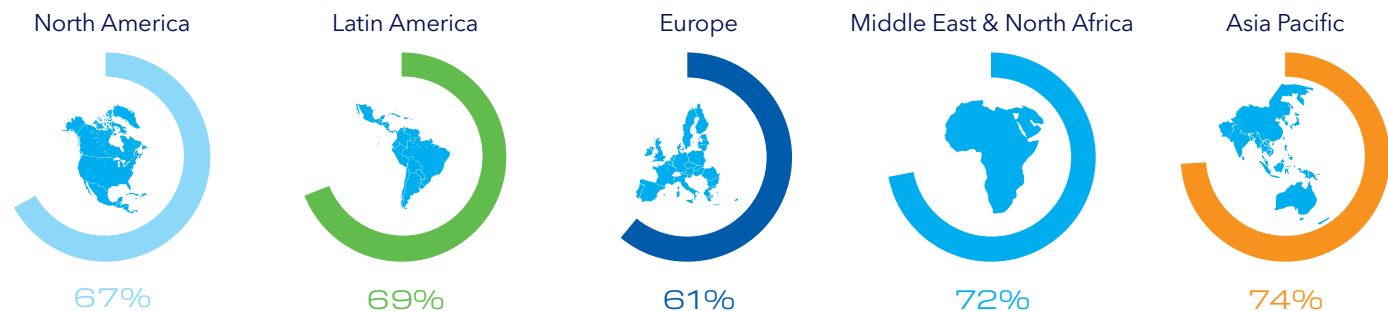
Likelihood of areas to be outsourced by oil and gas operators in 2019



27. Archer to boost Norwegian headcount to 2000 by year-end | Offshore Energy Today: <http://bit.ly/2RoRnTf>
 28. Higher Oil Prices Bring New Projects, Jobs To The Oilfield Service Sector: <http://bit.ly/2RLkm2Z>
 29. Offshore safety services group eyes new growth - News for the Oil and Gas Sector: <http://bit.ly/2MbfgY7>
 30. PD&MS to increase headcount by 25% following spate of contract awards - News for the Oil and Gas Sector: <http://bit.ly/2VRccFk>

31. Transocean wraps up \$2.7B Ocean Rig acquisition - Offshore Energy Today: <http://bit.ly/2AHtNqo>
 32. Consolidation of the oil and gas sector not fast enough: <http://bit.ly/2VRcRXk>

Percentage of respondents who expect increased consolidation of the oil and gas supply chain in 2019, by region



New models for co-operation?

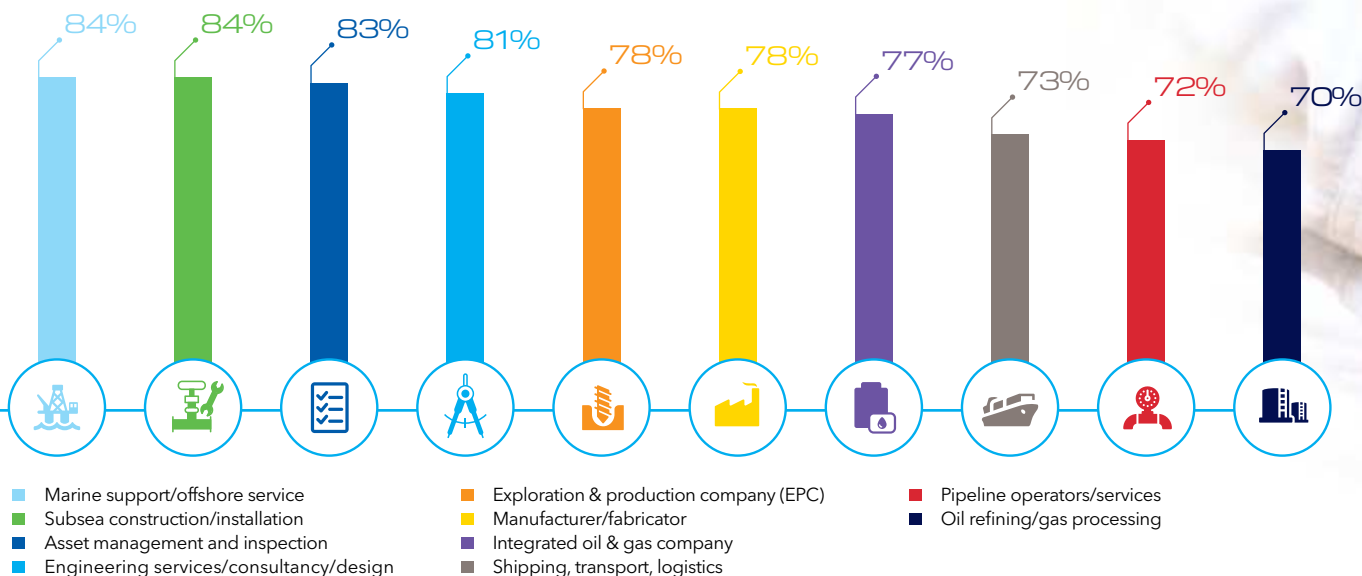
However, some industry leaders argue that fundamental change in the supply chain's way of working will be needed in the years ahead. Most of our survey respondents (77%) believe the industry needs new operating models to achieve further cost efficiencies. This proportion is as high as 90% in Latin America and 83% in Asia Pacific.

Flemming Horn Nielsen, operations director for INEOS Oil & Gas, says that it is time for traditional practices in the supply chain to be challenged: "One of the things we like to see in INEOS is new players on the supply chain side. We like to see different ways of doing it, and we definitely need to look at why we are still paying a lot more for the same products as compared to other businesses, especially in the offshore sector. I think we are still suffering from the period of very high oil prices, which still seem

to define some of the details in procurement specifications. My view is there are a lot of areas where we are still overpaying in the oil and gas industry."

Bespoke specifications for production facilities and components were common when the oil price was high, but cost and time efficiencies in procurement came into sharp focus during the downturn. The International Organization of Oil & Gas Producers, including BP, Total, Sonangol, Eni, Shell, Woodside, Engie, Saudi Aramco, Chevron and Equinor - kicked off a joint industry project (JIP33) in 2015 to make procurement more cost efficient through industry-level standardization.³³ The initiative initially listed only three items such as subsea trees and wellhead equipment but has grown since then, with 13 deliverables in 2018.

Respondents who agree that the industry needs to develop new operating models to achieve further cost efficiencies, by type of company:



In order to meet the challenges related to cost inflation, contracts may also need to evolve to suit new types of collaboration. Our survey shows that many suppliers hope to enter new agreements as partners rather than as vendors.

Overall, buyers (78%) are more likely to continue to favour a traditional procurement model based on price competitiveness than suppliers (62%). However, more suppliers (57%) than buyers (51%) favour models that are based on partnerships with shared risks and rewards.

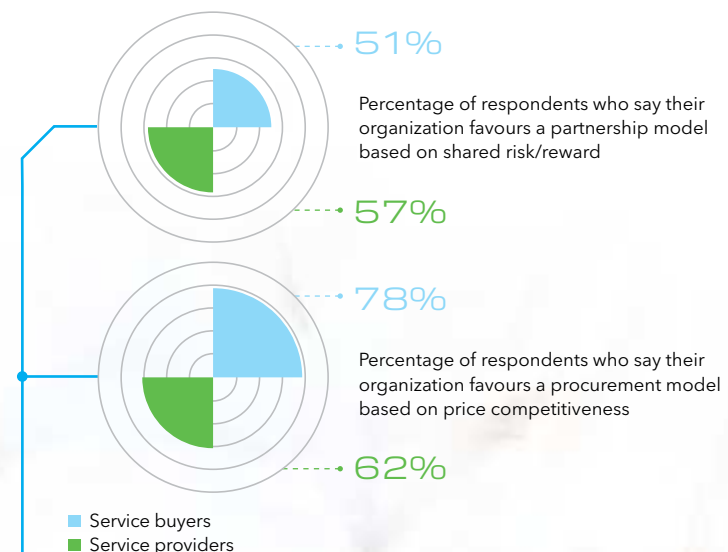
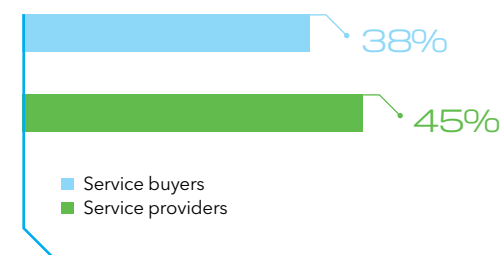
This may re-engineer the relationship between buyer and supplier as part of a wider drive to evolve more equitable operating models. For example, oilfield services company Schlumberger has been buying equity stakes in fields over the past few years to be more involved in operational decisions, contracting for exploration and production work.³⁴

Oil services company Baker Hughes also announced a new partnership with Abu Dhabi National Oil Company (ADNOC) Drilling in November 2018 by taking a 5% stake in the national oil company's drilling unit.³⁵

But not all service providers have the same capacity for risk as Schlumberger or Baker Hughes. Graham Bennett, vice president, DNV GL - Oil & Gas, warns: "I don't think there is sufficient trust in the industry to foster the acceptance of risk-reward relationships. Much of the supply chain has experienced disappointing outcomes experiences from this kind of relationship."

Indeed, 41% of respondents to our survey say that trust and relations between operators and suppliers have been harmed in the past three years.

Percentage of respondents who agree that trust/relations between suppliers and operators have been harmed over the past three years



33. JIP33: Standardization of equipment and packages: <http://bit.ly/2VRUprt>

34. The next oil major? Service firm Schlumberger's big bet on production - Reuters: <https://reut.rs/2Fom84t>
 35. Baker Hughes acquires 5 percent of ADNOC Drilling for \$550 million - Reuters: <https://reut.rs/2FycUSr>

04

SHORT-TERM INCENTIVES COULD ACCELERATE LONG-TERM DECARBONIZATION

Fossil fuels will remain an important component of the world's energy system for decades to come. However, the world will steadily transition to lower-carbon alternatives. This presents the oil and gas industry with a set of strategic choices that grow in urgency each year.

"Not long ago, the industry regarded the energy transition as a transformation on the horizon. That perspective has now changed. From our conversations with a diverse range of companies over the past year, it has become clear that this significant change is already upon us," says Liv Hovem, CEO, DNV GL - Oil & Gas.

Many companies are getting more proactive about the energy transition and driving change from within the industry. Thina Saltvedt, senior advisor for sustainable finance, Nordea Bank, says the oil and gas companies that succeed in the energy transition will be those that don't shy away from this change. "Lots of companies are starting to change direction, and they need to start now, not in five years. You cannot wait to be pushed to do it, you need to start a long-term strategy now so that technology and capabilities have time to develop, probably over ten years."

Short-term incentives required

Our survey shows that about half (51%) of the industry will focus on actively adapting to a less carbon-intensive energy mix in 2019, up from 44% last year. However, this differs considerably by market.

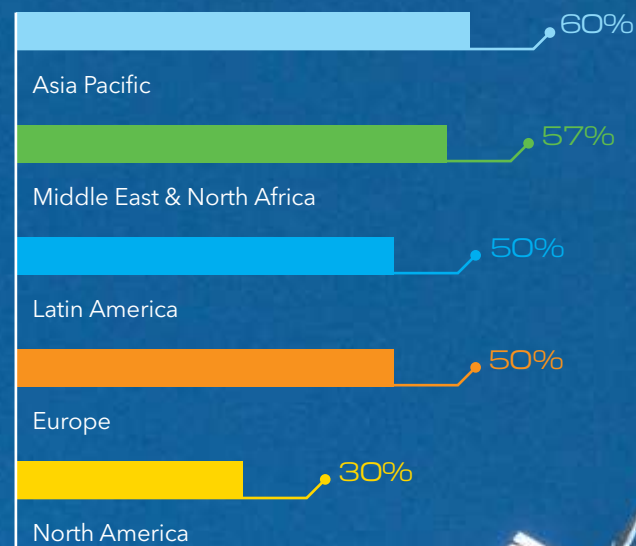
This energy transition activity is most pronounced in the Middle East and North Africa (57%), and Asia Pacific (60%) regions. In contrast, only 30% of companies in North America are doing the same.

Frank Ketelaars, regional manager, the Americas, DNV GL - Oil & Gas, says that North American companies are aware of the need to decarbonize, but the debate remains very political. "In the US,

it is a very polarized debate now. There are things happening, but it is very dependent on different states. Some are really driving it, like California, while others have less of an incentive."

While momentum for long-term decarbonization is building in the oil and gas industry, our survey indicates that companies today are more likely to be doing so because they are told to, rather than because they want to. Indeed, nearly half of respondents (46%) to our survey believe high oil prices could delay the industry's shift towards decarbonization, as companies concentrate on making short-term gains from newfound efficiencies and improved margins.

Percentage of respondents who say their company is adapting to a less carbon-intensive energy mix, by region



Meanwhile, regulation topped the list of factors most likely to drive oil and gas companies to decarbonize their operations in 2019, according to our survey. The energy transition and 'doing the right thing for society' came in ninth and tenth place, respectively.

The effect of regulation incentivizing decarbonization is also evident in other parts of the world. China's updated plan for tackling air pollution, published in July 2018, is an example of efforts to improve quality of life in major cities.³⁶ The country's 'Blue Sky' policy aims to reduce emissions of nitrogen oxides and other pollutants by at least 15% from 2015 levels by 2020.

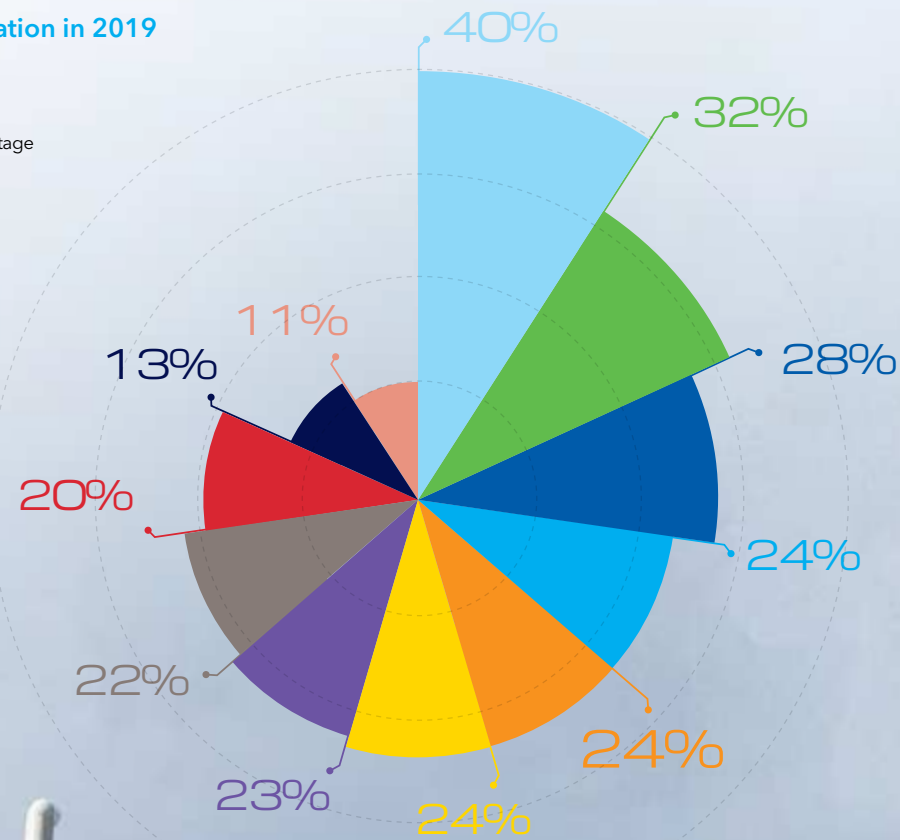
The policy is already believed to be paying off, and our survey suggests that it is prompting oil and gas companies operating in China to reduce the carbon intensity of their projects and operations. Related to this, about six in ten (61%) senior oil and gas professionals based in China say their organizations are actively preparing for the energy transition.

Yuan Zhengang, deputy director of the Oil & Gas Institute at PetroChina Planning and Engineering Institute (CCPEI), says it is crucial for firms to start planning and acting now. "Both big and small companies have to face this issue, and they must all be prepared to respond positively. The transition needs long-term sustainable investment, and the sooner they start planning and acting, the better. Big companies have advantages in technology, talent, and capital. But in the end, the energy transition relies on R&D and innovation to succeed."

36. China releases 2020 action plan for air pollution - China Dialogue: <http://bit.ly/2FqXoZ4>

Primary drivers for decarbonization in 2019

- Regulations
- Social/political pressure
- Business opportunities/competitive advantage
- Carbon pricing
- International agreements (e.g. COP21)
- Reputation and brand
- Oil and gas prices
- Technology innovation
- Long-term energy transition
- "Doing the right thing" for society
- Industry standards



Investor activism

After regulation, social and/or political pressure is the second greatest decarbonization driver for our respondents. For instance, there is increasing public pressure on sovereign wealth funds and institutional investors to create lower-emissions portfolios.³⁷ This is reflected in our survey results, where more than half (55%) of publicly listed, and nearly two-thirds (64%) of state-owned companies, are actively adapting to a less carbon-intensive energy mix in 2019. These proportions are far greater than for privately owned companies (43%).

An example of such pressure came in December 2018 when a group of shareholders, with a total of USD1.9 trillion (tn) under management, called on ExxonMobil to set targets for cutting its greenhouse gas emissions.³⁸ These demands come on the back of plans announced by Shell, Europe's largest oil company, earlier in the month to set carbon emissions targets for its business during 2019.³⁹

Thina Saltvedt at Nordea says: "There's a lot of pressure from the investors, and it is interesting to see that some investor groups are starting to pull out from shale oil, for example. Lots of investors support sustainability. It now has a major impact on brand name sentiment, but it is also about long-term survival."

Some oil and gas companies are taking steps to signal a definitive broadening of focus from hydrocarbons. Denmark's DONG Energy divested its entire oil and gas portfolio in 2017. It rebranded as Ørsted, focusing entirely on power generation and renewable energy. Shortly after, in 2018, Norway's multinational oil and gas company Statoil rebranded as Equinor, signaling an intention to become "a broader energy company".⁴⁰ Companies in other regions also followed the trend. Canadian company Painted Pony Petroleum became Painted Pony Energy, and in West Africa, Mobil Oil Nigeria rebranded as 11 plc. In recent years, at least eight oil and gas companies have rebranded to drop the terms 'oil' or 'gas' from their names.⁴¹

One-third of respondents to our survey said that they are looking to increase their investment in renewable energy in 2019. Respondents from companies that already have operations across the oil and gas value chain are most likely (41%) to broaden their portfolios beyond fossil fuels this year.

Oil majors have already begun to branch out into renewable energy and the electricity supply chain.⁴² Shell, for example, has acquired First Utility, an independent energy supplier to UK households, and also taken a USD217m stake in US solar developer Silicon Ranch.⁴³ Similarly, BP announced last year that it is looking to acquire more green energy firms, building on a deal by Total to take a stake in renewable energy firm Eren.⁴⁴ According to a recent Wood Mackenzie report on the shift by oil majors towards renewables, the primary driver is a desire to reposition towards a growing renewables market - and the stable long-term cashflows that could provide.⁴⁵

This trend is helped by the increasingly attractive business case that the renewable energy market presents - aided primarily by the falling capital cost of renewables through advances in technology and competitive bidding for new generation projects.⁴⁶ Subsidy-free contracts are advantageous for governments and are expected to increase in Europe, especially in Germany and the Netherlands where tenders for subsidy-free offshore wind farms were awarded last year.⁴⁷ The International Renewable Energy Agency (IRENA) reported in early 2018 that the levelized cost of electricity from solar photovoltaics decreased by 69% between 2010 and 2016 - coming into the cost range of fossil fuels.⁴⁸

Respondents citing regulation among the top three drivers for decarbonization, by region

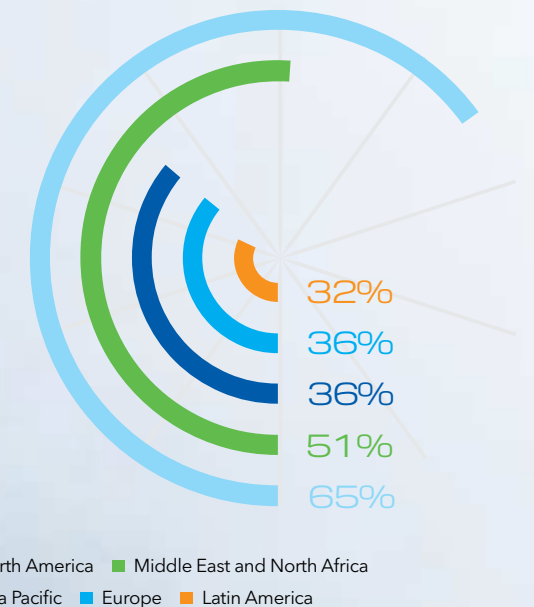


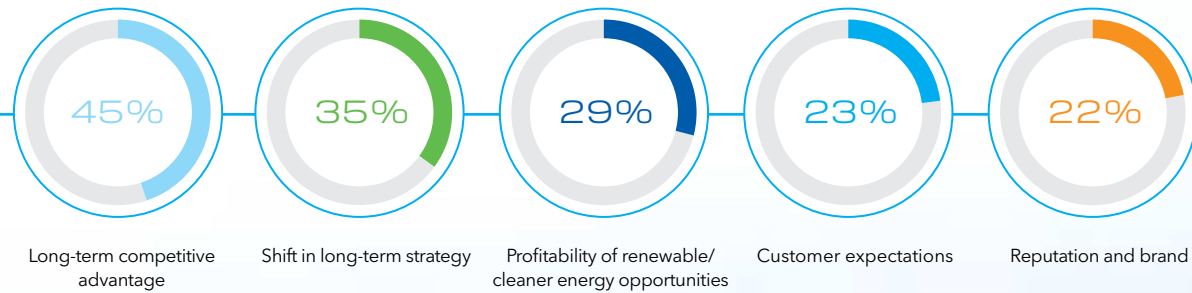
Image courtesy of Technology Centre Mongstad (TCM).

37. USD 3 Trillion Commit to Paris Goals: <http://bit.ly/2CjDM5j>
 38. Financial Times: <https://on.ft.com/2ALmiih>
 39. Financial Times: <https://on.ft.com/2RSI8KE>
 40. Norway's Statoil to rebrand as Equinor: <http://bit.ly/2QNdxtb>

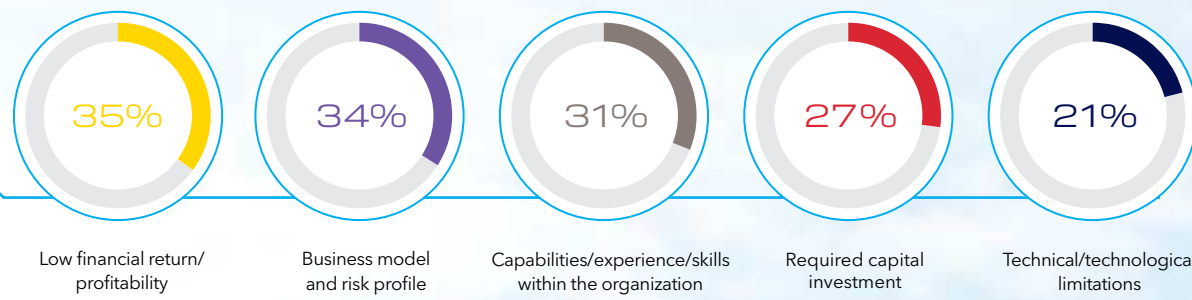
41. Statoil drops "oil" from its name - Quartz: <http://bit.ly/2FzI8d4>
 42. Financial Times: <https://on.ft.com/2FvjhD>
 43. Shell ventures back into solar - Reuters: <https://reut.rs/2AIRrD6>
 44. BP invests more in renewables: <http://bit.ly/2RLpCnf>

45. Renewables on the rise: <http://bit.ly/2FrF4z4>
 46. Cheaper Fossil Fuels By 2020: <http://bit.ly/2VN6413>
 47. More 'Subsidy-Free' Offshore Wind: <http://bit.ly/2QMCm8G>
 48. Renewable Power Generation Costs in 2017: <http://bit.ly/2Fzn45S>

Top five drivers of investment in renewable energy in 2019



Top five barriers to investment in renewable energy in 2019



Gas gets greener

While momentum for diversification into renewable energy is building, the industry also continues to shift focus from oil to gas, the least carbon-intensive of the fossil fuels.

DNV GL's 2018 Energy Transition Outlook forecasts that gas will overtake oil to become the primary energy source in the mid-2020s, with global oil demand peaking in 2023, and gas demand peaking in 2034.⁴⁹

More than a third (35%) of respondents to our survey said that their organizations will increase investment in gas-focused projects and portfolios during 2019. The long-term energy transition tops the list of drivers for this spending, closely followed by the growing importance of importance of LNG as a transportation fuel.

The market potential for gas is clear: almost half of respondents (48%) to our survey believe that gas will overtake oil to become the world's primary energy source

before 2025, and 43% believe that demand for gas will exceed supply within the next five years.

Despite a firm year for the US Henry Hub benchmark, based on seasonal demand, natural gas prices in the US are expected to remain range-bound in 2019,⁵⁰ and continue to be an attractive source of energy for the country's fuel mix.

Cliff Johnson, president of the Pipeline Research Council International (PRCI), says that natural gas is a key part of the energy equation, at least in the short term. "Gas is a very economic fuel right now. For countries such as the US it is extremely convenient to have natural gas as part of the equation. As long as it stays as cost effective as it is now, there is no need to rush away from natural gas. The industry is working to enhance emerging fuels, but we need to do it with a systematic process," he says.

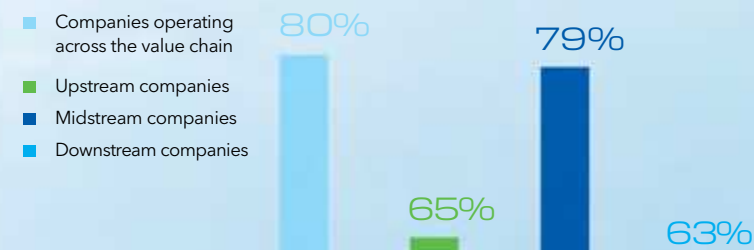
There is more to the industry's focus on gas than its low-carbon profile relative to oil. Research and development efforts are being put into making it possible to decarbonize the gas that heats homes and businesses, by introducing green gases such as hydrogen into national transmission and distribution systems.

Antony Green, head of engineering and asset management at the UK's gas transmission network owner and operator National Grid, says that gas needs to become more environmentally friendly if it is going to have a long-term future. "Is this decarbonization commercially viable at the moment? No, not yet. But the gas sector is making rapid advances and current research indicates that gas could provide a viable pathway."

"The transition needs long-term sustainable investment, and the sooner [companies] start planning and acting, the better"

Yuan Zhengang, deputy director of Oil & Gas Institute, PetroChina Planning and Engineering Institute (CCPEI)

Respondents who say they will maintain or increase investment in gas projects/portfolio in 2019



49. Energy Transition Outlook 2018 - DNV GL: <http://bit.ly/2HeQLLg>
 50. Short-Term Energy Outlook - U.S. Energy Information Administration (EIA): <http://bit.ly/2H7NlKa>

The growing importance of hydrogen

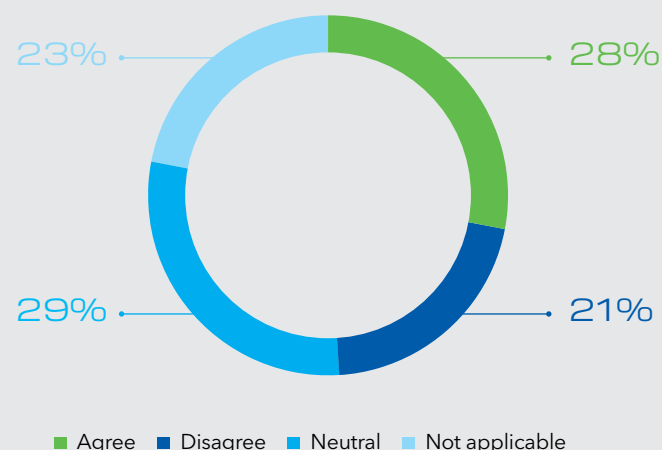
DNV GL analysis predicts a 100,000-fold rise in demand for hydrogen for energy by 2050.⁵¹ Australia, Canada, the Netherlands, the UK and the US are most likely to adopt hydrogen at significant scale for heating residential and commercial spaces. This is because natural gas currently provides a high proportion of the energy for heating in these countries, and their existing gas infrastructure can be adapted to hydrogen distribution and storage. Existing carbon-capture storage (CCS) operations in these countries further support the use of hydrogen.

Over a quarter (28%) of respondents to our survey expect significant increases in the use of hydrogen to decarbonize the gas mix in 2019, although a helping hand from governments will be key. Nearly three-quarters of respondents (73%) believe that government incentives or policies will be required to drive decarbonization of the gas mix.

For example, in the UK, a government-funded initiative led by NGN (Northern Gas Networks) is conducting research to test the use of hydrogen distribution in the UK's existing natural gas networks in northern England.

Antony Green at National Grid says there is a case for hydrogen being a potential energy carrier alongside methane: "R&D needs to be focused on the transmission network, so that we can understand how to transport blends with various levels of hydrogen. The distribution networks have really led the way on hydrogen, but the transmission networks are now starting to look at the role they can play."

Extent to which respondents expect significant increases in the use of hydrogen to decarbonize the gas mix in 2019



"The distribution networks have really led the way on hydrogen, but the transmission networks are now starting to look at the role they can play"

Anthony Green, head of engineering and asset management, National Grid

Our survey shows respondents from the Netherlands (42%) are most enthusiastic about investing in hydrogen. That is no coincidence - in 2018, the government set a target of 95% CO₂ emission reduction by 2050. Take, for example, Gasunie, owner of the national natural gas transmission network in the Netherlands, which has been quick to respond to the energy transition. It has converted a natural gas pipeline onstream in the southwestern part of the country for hydrogen transport. The company's vice president for corporate business development, Hans Coenen, says:

"I think that's quite important, because we have demonstrated that you can really give the natural gas grid a second life. I think there was a tendency, a couple of years ago, to think we would electrify everything via wind and solar. Now there is more insight into, and conviction about, the role green molecules can play in the future." Coenen believes that by 2050, 50% to 60% of our total energy mix will still be based on molecules. "However, these molecules need to be green," he says.

The dynamics of carbon capture

The vast majority (78%) of senior oil and gas professionals believe that their industry will only decarbonize if it makes financial sense for them to do so. This is a primary reason why carbon capture and storage - technology to capture carbon from industrial processes and prevent it from being released into the atmosphere - has seen limited uptake in the oil and gas industry since its inception in the 1970s.

CCS is the only available technology for decarbonizing oil and gas operations, and as climate issues intensify, interest and investment in CCS is again increasing. But, for as long as the cost of emitting carbon remains lower than the cost of capturing and storing it - as it always has done - large-scale adoption of CCS remains unlikely.

According to DNV GL's 2018 Energy Transition Outlook, 22 CCS facilities are currently in operation.⁵² Twelve of these are in North America and have viable business cases because they use CO₂ captured from hydrocarbons processing for enhanced oil recovery. US initiatives also benefit from Section 45Q tax credits, revised in 2018 to provide more money per ton of CO₂ captured, while removing a cap on how much can be injected underground.⁵³

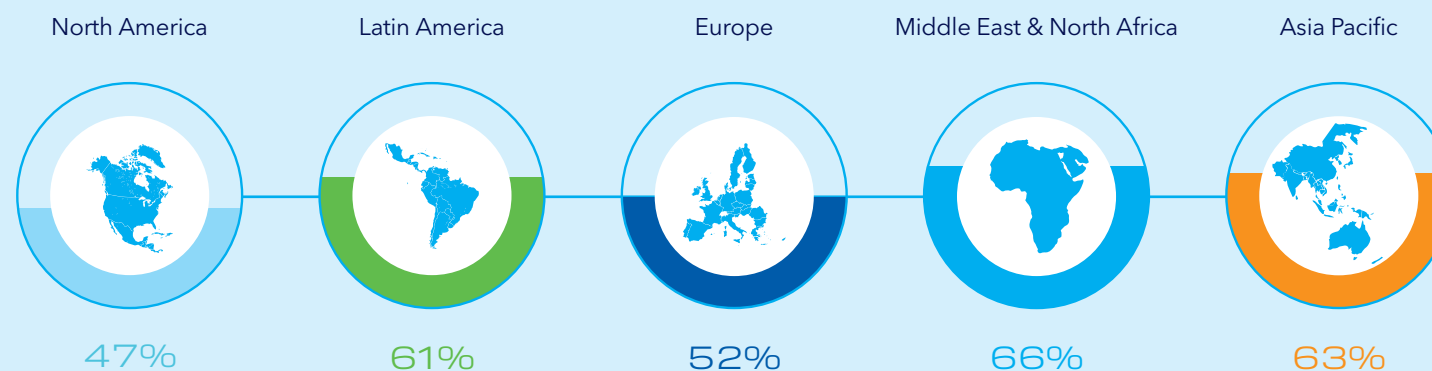
Government interventions, either through capital funding or regulatory incentives, are still necessary to make most CCS initiatives viable. The Gorgon project in Australia, for example, has committed to storing the carbon it produces, as part of its license to operate an LNG facility on Barrow Island.⁵⁴ Meanwhile, the UK government announced in 2018 that it aims to have the country's first carbon capture, utilization, and storage (CCUS)

facility fully operational from the mid-2020s.⁵⁵ It has committed GBP20m (USD25m) to developing CCUS technologies at industrial sites. Elsewhere, the Sleipner and Snøhvit storage projects offshore Norway are incentivized by a Norwegian carbon tax.⁵⁶ While this approach has proved to be fruitful, the likelihood of a global carbon price remains slim. Only a few (13%) of our survey respondents believe that a carbon-pricing model will be implemented in 2019, and 41% believe there will never be a globally effective carbon price.

The majority of senior oil and gas professionals (56%) believe that the industry, rather than governments, should take responsibility for the uptake of CCS. But, while the cost of implementing the technology remains high, it seems more time is needed - over a decade, according to DNV GL's 2018 Energy Transition Outlook - before industry leaders will be convinced there is a case for it.

Technology Centre Mongstad (TCM) in Norway collaborates closely with other CCS initiatives around the world, including the Oil and Gas Climate Initiative (OGCI) Clean Gas Project - the UK's first commercial full-chain CCUS project.⁵⁷ TCM's managing director, Ernst Axelsen, expects the cost of CCS to decline in the future. "I think the price will fall, both in operation and capex in the future, and we can see that emerging technologies are coming to make CCS viable at smaller scale and in wider industries," Axelsen says. "But the business models are still too weak. There have not been enough drivers dedicated to finding solutions for industry to actually implement CCS or CCUS in ways that make good business sense."

Extent to which respondents agree that the industry should be responsible for increasing carbon capture and storage uptake (rather than waiting for government policies), by region



51. New DNV GL research sees long-term expansion of hydrogen use for energy - DNV GL: <http://bit.ly/2M7xbzt>

52. Energy Transition Outlook 2018 - DNV GL: <http://bit.ly/2HeQLLg>
 53. Carbon Capture and Sequestration (CCS) in the United States: <http://bit.ly/2QOgxFw>
 54. Financial Times: <https://on.ft.com/2Cm5deB>

55. Plan to enable first UK carbon capture project - GOV.UK: <https://on.ft.com/2Cm5deB>
 56. Carbon capture and storage - Norwegianpetroleum.no: <http://bit.ly/2sqOK4l>
 57. UK's first commercial full-chain Carbon Capture, Utilization and Storage Project: <http://bit.ly/2TMjEQk>

05

EFFICIENCY EFFORTS DRIVE LASTING MOMENTUM IN DIGITALIZATION ADOPTION

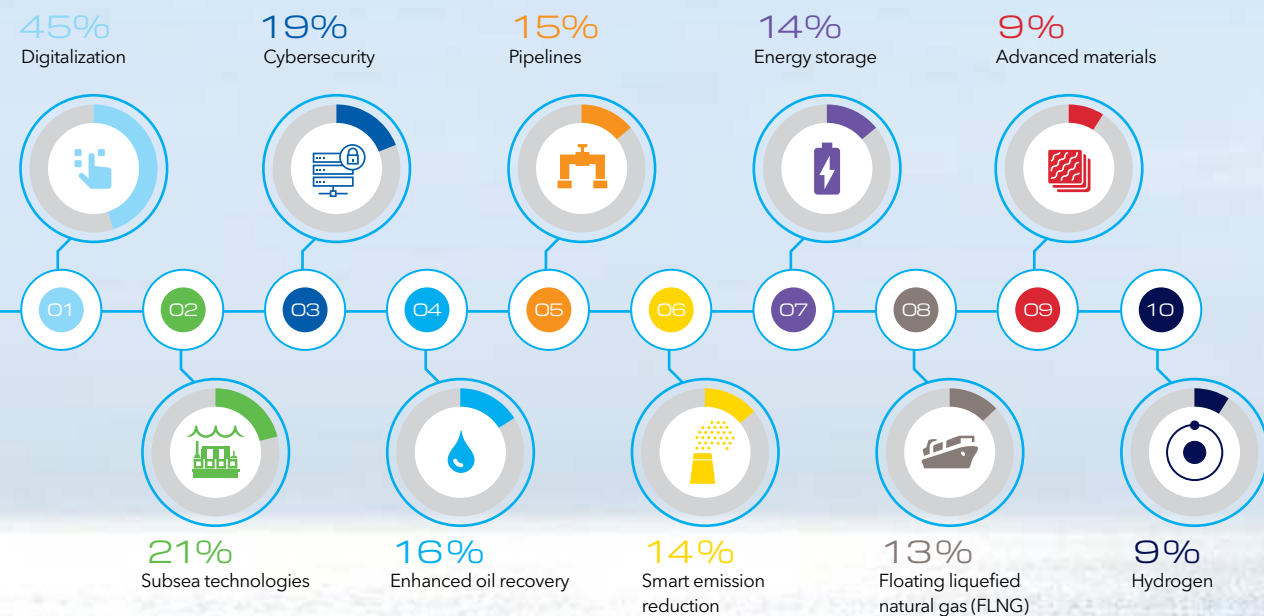
A tight focus on efficiency has been the status quo across the oil and gas industry ever since the downturn in 2014. It comes as little surprise, then, that much of the industry's research and development (R&D) spend is focused on technologies to enhance the efficiency of new projects or existing operations – and, in particular, digitalization.

This efficiency focus coincides with an expectation of rising R&D spending, which crept up in 2018 for the first time in four years. In 2019, more than a third (36%) of the senior oil and gas professionals surveyed expect increased R&D spending this year. Regionally, this is highest in Asia Pacific (44%) and Latin America (42%), but drops to just 12% in the Middle East and North Africa, and 25% in North America.

Digitalization is comfortably the leading R&D priority for the oil and gas industry in 2019, with twice (45%) the number of respondents to our survey investing in it compared to the second-ranked priority, subsea technology (21%).

Looking at wider investment in digitalization – including everything from R&D to full-scale implementations – six in ten (60%) respondents expect their organization to increase spending in this area in 2019. Like last year, it is the area most likely to see increased investment in 2019 (out of a wide range of categories, including capex, training, decarbonization, gas portfolios, safety and a dozen others).

Top 10 R&D priorities for investment in 2019



Overall, the sector is also looking to digital technology to provide the long-term efficiency and productivity gains it needs to maintain its competitiveness over the declining cost of renewable energy over the coming decades. According to a 2017 report by the World Economic Forum, digitalization has the potential to create around USD1.6tn of value for oil and gas firms.⁵⁸ This is not lost on industry leaders: three-quarters (73%) now say that their organizations need to embrace digitalization to increase profitability, compared to 49% in 2017.

The value that can be created by applying digital technologies to projects and operations has become increasingly tangible in recent years. One example comes from Songa Offshore, which has connected up to 600 sensors to each of its four oil rigs in the North Atlantic basin to help cut maintenance costs and increase operational productivity.⁵⁹

In the Middle East, ADNOC's Thamama Subsurface Collaboration Centre has the capability to monitor up to 120 live drilling sites simultaneously, comparing performance to historical data to improve rig efficiency, and ultimately reduce drilling cost.⁶⁰

Meanwhile in the UK, "National Grid will add more predictive maintenance to our assets as the value comes alive through the data systems that we're developing at the moment," says Antony Green, the company's head of engineering and asset management. "Digitalization is an area of great interest to us," Green adds.

In the US, many pipeline structures are almost a century old and continued maintenance warrants new technology. "We are building a pipeline data hub that will be the key repository of knowledge for the development of the next generation of tools, processes, and personnel for the industry," says Cliff Johnson, president of Pipeline Research Council International. "It is an effort to use everything we have learned in the last 60 years to help us in the next 60 years, and AI and other digital tools are fundamental to that."

In the Middle East, digitalization is also progressing, and the midstream sector is seeking to reduce repair and maintenance costs through deployment of 3D printing technologies, sensors, drones and robotics.⁶¹

Projects like these are common, and 60% of all respondents to our survey report that their organizations are planning to increase investment in digitalization in 2019, up from 54% that reported the same for 2018.

"Digitalization is entering a critical period – a qualitative leap – in the next five years or so"

Yuan Zhengang, deputy director of Oil & Gas Institute, PetroChina Planning and Engineering Institute (CCPEI)

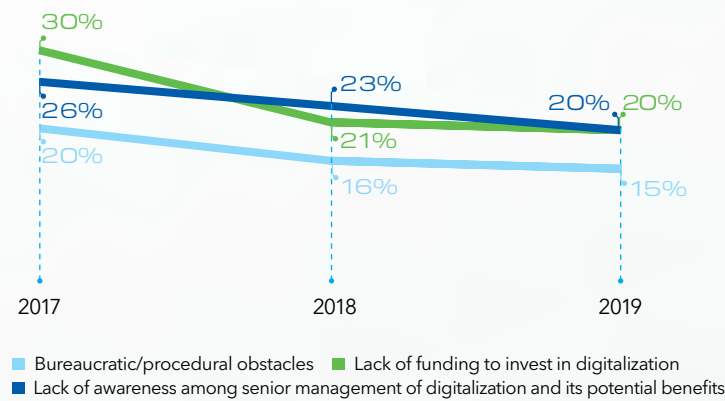


58. Digital Transformation Initiative - White Paper: <http://bit.ly/2EWZqw3>

59. Digital investments and new business models empower oil & gas companies to leverage industry recovery in 2018 - IFS Blog: <http://bit.ly/2HbwTZt>

60. AI Minister visits ADNOC's Artificial Intelligence, Big Data Centres: <http://bit.ly/2VUN80u>
61. Digitalization top priority for oil, gas decision-makers: <http://bit.ly/2Rv2Q3C>

Falling barriers to digitization



Shifting barriers

Part of the reason that digitalization is on the rise is that some of the barriers to adoption are falling. For example, over the past three years, our research has tracked a diminishment in the significance of barriers such as bureaucracy, insufficient funds, and a lack of awareness of the benefits of digitalization among senior management. As market conditions have improved, it is no surprise to see funding become less of a barrier, but the other factors reflect a greater organizational shift toward embracing digitalization.

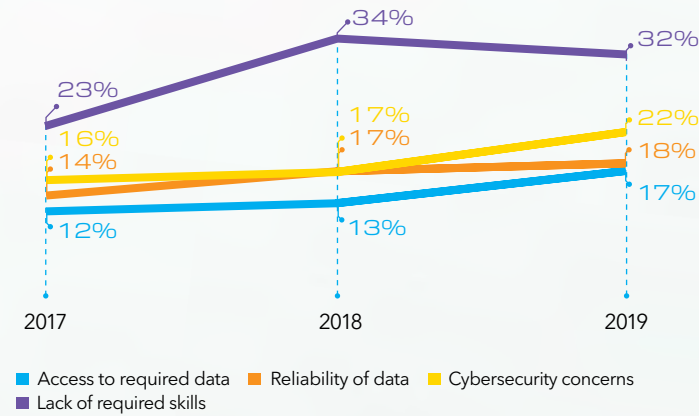
However, as some barriers have fallen over the past three years, other barriers have taken on greater significance. These upward-trending barriers are symptomatic of increasing adoption, and include:

- A lack of required skills - inevitable as companies compete to build their capabilities and accelerate digitalization
- Cybersecurity - with every added digital system, comes the added need to manage related digital threats
- Data access and data reliability - often these obstacles bite only once organizations move their digital ambitions toward full-scale implementation, and obtain full knowledge of their data-related challenges.

The data priority

This last point is fundamental - as a barrier or an enabler - in digitalization efforts in many parts of the industry. Nelson Queiroz Tanure, CEO of Brazilian company PetroRio, believes there is a lot of room for knowledge transfer. He sees data platforms and data sharing playing a key role: "We subscribe to certain services to benchmark some of our activities, such as drilling or analysing seismic data. Data as a whole is very important, and we invest a lot in being very up to speed. Access to reliable and diverse data is crucial".

Rising barriers to digitization



The rapidly maturing state of digitalization in oil and gas is accompanied by an increasing awareness of the extent to which organizations become dependent on their data. This makes it imperative for firms to be able to trust the quality of their data, while also having the ability to control data sharing across and outside the business, if they are to get the best possible outcomes from digital investments.

The top three priorities within the industry's digitalization agenda in 2019 all relate to data sharing, integration, and access, according to our survey. This is where many organizations realize that they need to invest, and two-thirds of respondents (67%) say their company will prioritize the quality and availability of data in 2019 - a number that rises to 75% among Asia Pacific respondents.

China National Petroleum Corp (CNPC) exemplifies this trend, having established a large-scale SAP database to improve data integration, quality, and access times.⁶² The project is part of CNPC's relentless digitalization agenda, which also includes the new Exploration & Development Integrated Research and Application Platform, called 'A6', which aims to integrate all the core data from the whole upstream business into a single shared platform.

Yuan Zhengang, deputy director of the CCPEI's Oil & Gas Institute, says: "Once the A6 platform is established, the data of all CNPC's upstream oil and gas fields, including data from all its research institutions, can be shared. The data is standardized and structured, and the data quality can be guaranteed and fully shared in real time."

Shared risk

More than half (60%) of respondents say that cost pressures will drive greater collaboration between their organizations and other industry participants in 2019. Digitalization has the potential to make collaboration easier, particularly for large organizations with projects that involve the co-ordination of thousands of employees and contractors.

Kamal Bahrin Ahmad, CEO of PETRONAS Gas Berhad, says: "By deploying pervasive wireless technology for the first time during our recent plant turnaround, PETRONAS Gas was able to track - on a real-time basis - the movement and location of every employee and contractor working in our plant. This has greatly help to raise our confidence around managing everyone's safety. It also improved productivity as we can identify at any moment, how long each worker spends in active production zones and how much time is spent idling or resting. Ultimately, this digital solution will help to drive cost efficiency in addition to safeguarding our people."

"The biggest challenge when we implemented digital tracking was to gain people's acceptance, as some did not initially like being tracked or monitored in real time," he says. "But, our change management programme has helped them to see the benefits and allowed us to gain good traction on the project. Once they understood the safety and efficiency benefits, they were very receptive and open to more digital solutions," says Ahmad.

As investments in digitalization increase, and as collaboration and the need to share data between organizations become more integral to everyday operations, the need for cybersecurity is increasing exponentially. A 2017 survey by Ponemon, a data security research institute, found that 68% of US cybersecurity risk managers in the oil and gas industry had suffered at least one security compromise involving information loss or operational disruption at their organization over the past year.⁶³

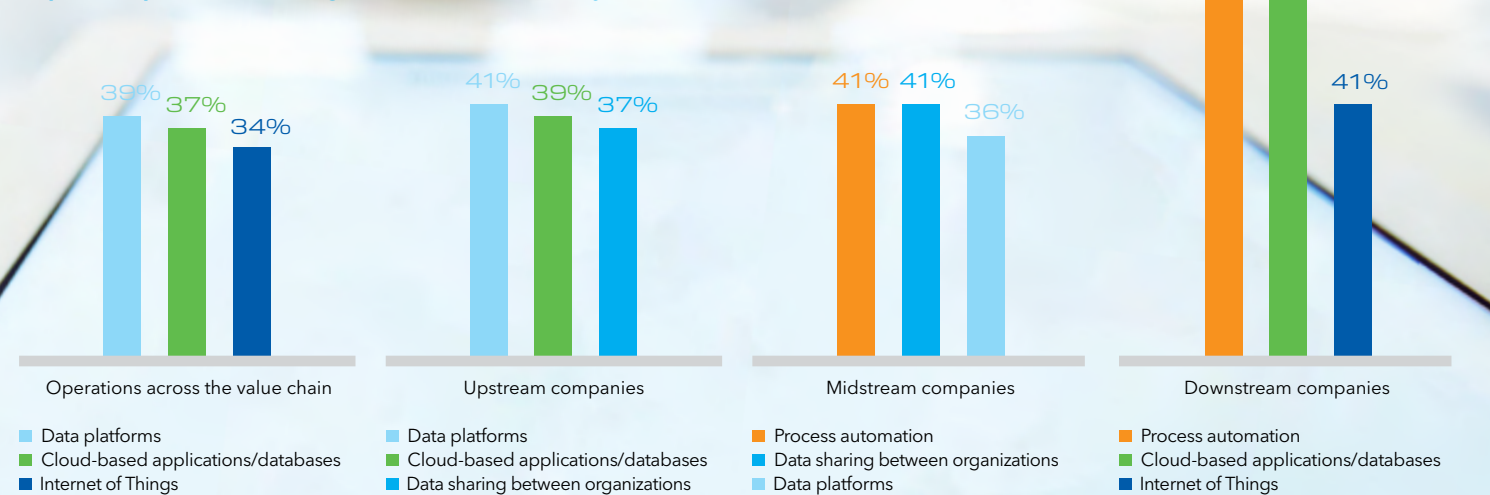
In March 2018, the United States Computer Emergency Readiness Team (US-CERT) released an alert⁶⁴ that foreign government cyber actors had targeted the networks of small US commercial facilities with malware and spear phishing, gaining remote access to energy sector networks. Later in the year, Italian services company Saipem's servers in the Middle East and India were hit by malware,⁶⁵ taking hundreds of computers offline. And further downstream, the WannaCry cyberattack saw more than 20,000 petrol stations go offline in China in 2017.⁶⁶

Our survey finds that the industry is investing in cyber defences: 45% of companies are increasing spending on cybersecurity in 2019, with a further 36% maintaining their current level of investment. Large companies (those with annual revenue in excess of USD5bn) are increasing spending (60%) at a faster rate than organizations with revenues of less than USD500m (37%).

Cybersecurity is, of course, only as strong as its weakest entry point. With 42% of large companies planning to increase their use of contractors in 2019, there is a rising risk of cyber vulnerabilities created by collaborations with smaller players that have not invested sufficiently in their digital defences.

With strong momentum behind digitalization efforts, it is likely the industry will rise to overcome these challenges. Most in the industry understand that digitalization is not an overnight solution to all their problems - as some of the hype would have us believe - but many are incrementally realizing benefits from things like automation, data insights, predictive analytics, situational awareness and advanced process control. As Yuan Zhengang, deputy director of the CCPEI's Oil & Gas Institute, puts it: "Digitalization is entering a critical period - a qualitative leap - in the next five years or so."

Top three priorities for digitalization in 2019, by sector



63. Study reveals cybersecurity readiness gaps in US oil and gas industry: <http://bit.ly/2VOZebr>
 64. Russian Government Cyber Activity Targeting Energy and Other Critical Infrastructure Sectors - US-CERT: <http://bit.ly/2RM8z4j>
 65. Saipem says Shamoon variant crippled hundreds of computers - Reuters: <https://reut.rs/2TSqSm3>
 66. Tens of thousands of Chinese firms, institutes affected in WannaCry global cyberattack - South China Morning Post: <http://bit.ly/2ANEjwv>

62. CNPC Builds the World's Largest SAP HANA Cluster: <http://bit.ly/2Rv3Ch2>

CONCLUSION: PREPARING FOR THE UNEXPECTED

In 2019, the oil and gas industry will engage a diverse set of opportunities and challenges. As in recent years, political, legal and regulatory forces are likely to continue to make a large part of this patchwork. There have been examples in recent years of eventualities that would have been hard to predict, even as near as a year before they began, including China's rapid shift away from coal⁶⁷ or the relaxation of environmental rules in the US.⁶⁸ In some places, such as Europe's energy marketplace, there is a growing need for regulatory certainty on national energy and climate plans.⁶⁹

"The way the market is organized in Europe is still quite a challenge, because when you look at legislation and regulation it is based on a traditional gas and electricity structure," says Hans Coenen, vice president for corporate business development at Gasunie. "Today's world is more complex, with all kinds of renewable energy factors - solar, wind, green gas, hydrogen, CCS transport sources - and more connections between organizations and countries. Gas and electricity laws need to be adapted for this new world. To achieve our goals, as companies and nations, we have to work quite hard on reducing all the barriers in relation to legislation and regulation."

Balancing barriers

The recent increase in price volatility has come at a time in which many companies are looking to expand and invest, while also battling increasing competitive pressure and cost inflation. A number of the industry's heavyweights are more resilient and confident than they have been for years, while the supply chain has yet to find a sustainable long-term balance in the new oil price reality.

This presents a need for some difficult balancing acts from organizations. "If the price stays at the levels we saw in December, instead of coming back up to USD70 or USD80, perhaps the

industry will be slightly more cautious around new investments," says Eirik Wærness, senior vice president and chief economist of Norwegian multinational energy company Equinor. "But that's not so much a strategic decision, it's just a matter of being slightly more cautious in terms of your ability to fund and run these projects to the same extent that you would if prices were higher."

Over the longer term, major operators are planning their spending strategies based on a long-term oil price of USD50-USD60 a barrel⁷⁰ and this likely means that short-term volatility will not stall the capex plans that were put in place in the (more stable) first 10 months of 2018.

Indeed, as industry disruption grows - be it from energy transition, emerging technologies, politics or competition - each year makes longer-term strategic shifts more urgent and important. As Kamal Bahrin Ahmad, CEO of PETRONAS Gas Berhad, explains, these plans are often tied to national and international priorities: "We need to have the right energy mix in Malaysia. Gas continues to be our anchor fuel. It is, of course, cleaner and more affordable than some alternatives. But as a country, we also take a strategic view on our fuel mix. Like all nations, we need to consider many factors, including security, stability, affordability and the environment. So, while we have moved our energy ratio towards gas, we will always need to keep evolving a balanced energy mix, including increasing renewable energy and managing other sources."

The power downstream

The long-term view often overlooks the role of petrochemicals in oil and gas demand. The IEA's executive director, Fatih Birol, has described the segment as "one of the key blind spots in the global energy debate," because it will have a bigger impact on the future of oil demand than aircraft, trucks, or cars.⁷¹

Flemming Horn Nielsen, operations director of INEOS Oil & Gas Denmark, echoes this: "When we talk about the future of the oil and gas industry, often the focus is on energy and transport, but a lot of the reduction in fossil fuels in those areas could be completely outweighed by increased consumption of plastics as populations grow bigger and wealthier. When you think about computers, fertilizers, phones, nylons, tires, clothes - there are hundreds of applications that are often forgotten when we think about only direct energy consumption."

By contrast, the oil and gas industry is in no danger of overlooking decarbonization as a key force influencing its future. There has been sustained momentum since the COP 21 Paris Agreement, and the industry remains, ostensibly at least, committed to reducing harmful emissions and environmental impact. While there is no doubt about this direction, there are questions over the rate of progress and how it is impacted by industry cycles, profitability and regulations.

As Ernst Axelsen, managing director of TCM, says: "Everyone is aware they have to do something. But every industry needs to address decarbonization from its own point of view, in terms of the business case, incentives, investments and initiatives. The oil and gas industry is clearly acting. The Oil and Gas Climate Initiative (OGCI) now has 13 companies, representing about 30% of the industry, and recently increased its fund for new technologies, projects, and business solutions from USD1bn to USD1.3bn."

We should not underestimate the significance of this commitment. The year ahead is difficult to predict, but it seems we can now rely on the industry to continue along greener pathways, even if the pace can vary. Apart from this, while the industry is confident and resilient, we still appear to live in uncertain times. So, while many indicators in our outlook for 2019 are clear and compelling, it also seems wise to expect surprises.

"Today's world is more complex, with all kinds of renewable energy factors [...] and more connections between organizations and countries"

Hans Coenen, vice president, corporate business development, Gasunie



67. How China cut its air pollution - The Economist explains: <https://econ.st/2HIYuXM>

68. EPA admits scrapping regulations will put more methane into atmosphere: <http://bit.ly/2sqSxPI>

69. Clean energy for all Europeans - Energy: <http://bit.ly/2AJMoU>

70. Equinor won't cut spending - Kallanish Energy News: <http://bit.ly/2FrGPMW>

71. Petrochemicals set to be the largest driver of world oil demand: <http://bit.ly/2HcixYQ>

DNV GL AS

NO-1322 Høvik, Norway
Tel: +47 67 57 99 00
www.dnvgl.com

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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.