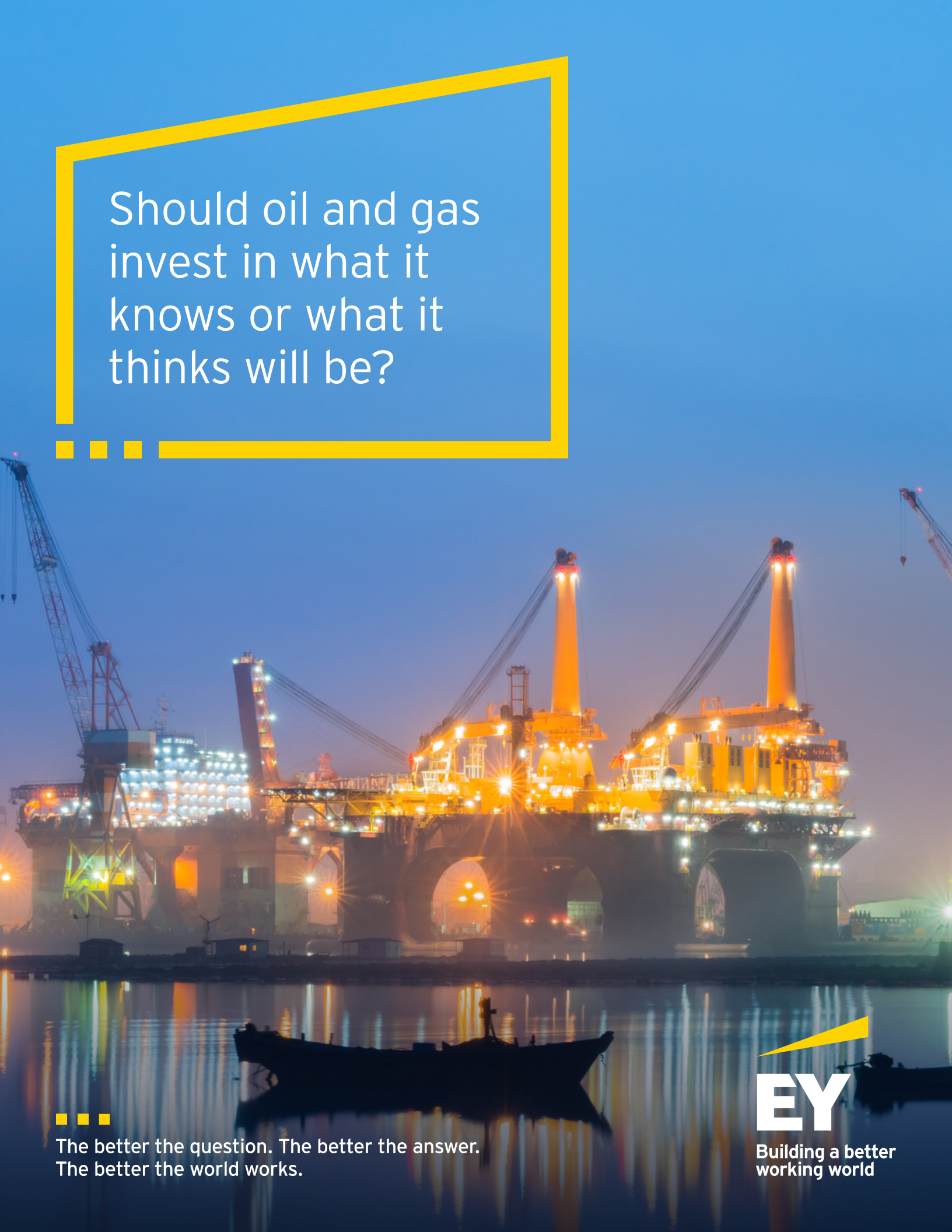
Should oil and gas invest in what it knows or what it thinks will be?



The better the question. The better the answer.
The better the world works.

Building a better working world

It is no news that the energy landscape is in a state of disruption, driven by:

climate change and the role of oil and gas are increasingly a factor in consumers' choices, companies' investment strategies and government policy.

electricity has been and likely will always be the vehicle for broader and more extensive use for energy. Its flexibility is unmatched and can be generated using the full spectrum of fuels, fossils and renewables.

energy businesses will increasingly rely on technology to gather higher volume data, perform more sophisticated analyses and create more precise process control.

the downturn in oil prices has motivated a step-change in process improvement and cost reduction across the oil and gas value chain, and utilities and renewable energy companies are scaling. As they do, they will gain experience and costs will fall.

digitization will enable customers to choose from a wider variety of energy suppliers, produce energy themselves, and buy energy from or sell energy to other energy users. As they do, alternative technologies will have an increased opportunity to compete.

the developing economies are still energy-intense, and high economic growth generates a voracious appetite for energy to fuel it.

Evidence of climate change continues to accumulate, and notwithstanding the tension among the rhetoric, the ambition and the reality of the facts on the ground, we foresee increasing pressure on governments, consumers and the energy industry to decarbonize the production and use of energy. The operative questions are not "if" but how, when and who. These are not uncomplicated questions, and there are many unknowns. In an ideal world, we would flip a switch and the energy ecosystem would be magically transformed. Electric vehicles would instantly replace those powered by internal combustion engines (ICEs), and all electricity would be generated by solar panels and windmills.

We do not live in that world. Of all the complex issues facing our world, the transition to a lower-carbon future may be one of the biggest. There are big and existential questions about our path toward clean (or cleaner) energy and the role of oil and gas.

- How fast will the transition be?
- How complete will it be?
- How can companies balance conflicting investor demands for traditional returns versus concerns about climate change?
- How will industry balance the need to invest in the future with the uncertainty in demand?
- How much can governments afford to subsidize or tax to accelerate the transition?
- How will capital markets respond?

We've looked at the disruptive forces acting on the industry through a consumer lens (what people want), a technology lens (what industry can deliver) and a regulatory lens (what the government will incentivize and permit). We've developed a framework that allows us to look at how the various risk factors might move oil and gas demand and returns.

We've distilled them into four scenarios, without preference — Meet me in Paris, The slow peak, The long goodbye and Critical gas — based on different combinations of five key variables.

1. Consumer accceptance of electric vehicles (EVs) — EVs are increasingly cost- and performance-competitive, but consumers do not always want or end up buying what we might think of as the best or cheapest alternative. Inertia matters, and there is risk that EV market share may grow less quickly than we all expect. If that happens, oil demand may grow for a while.

2. Energy efficiency — the long-run trend of ICE-powered cars is better fuel efficiency. Between 2005 and 2015, the number of vehicles in the world increased by about 4%, while the demand for oil increased by about 1.2%. That trend will continue, but we don't know how quickly.

3. Relative attractivess of renewable electricity — solar panels and batteries are getting cheaper. In fact, they're the cheapest form of generation in most markets. Advancements in hydraulic fracturing and digitalized exploration and recovery have substantially decreased the cost and price volatility of natural gas, setting up a complementarity that will persist for the time being.

4. Future of nuclear and coal — as electricity demand has grown in the developing world, coal has been the fuel of choice. It's cheap, the technology is easy to implement and supplies are reliable. If the world stands any chance of meeting its climate change goals, this cannot continue. Nuclear is a low-carbon alternative, but the cost of making it safe appears to be prohibitive. Almost every baseline forecast assumes an ongoing role for coal, particularly in developing markets, and nuclear, though with limited growth of new nuclear plants outside of developing markets. If those expectations aren't met, there's the potential of an outsized role for natural gas.

5. Concentration of economic growth — petrochemical, industrial and aviation oil and gas demand are far more sensitive to economic growth in developing countries than in developed countries. In the recent past, free trade policies have worked in favor of growth in China and India. Those policies are being challenged, and there are signals of increasing risk.

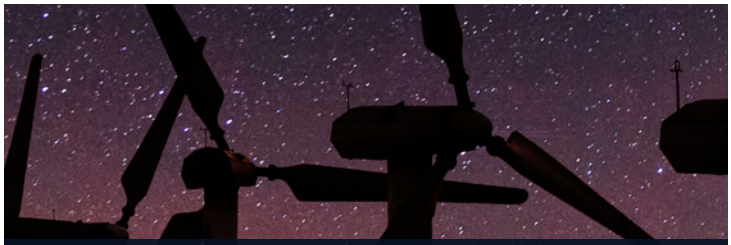
We've looked at the impact of these drivers to help our clients understand:

- The impact of disruptive forces on asset returns
- The early indicators that we're moving toward a particular scenario
- The decisions industry participants can take that will work under most scenarios; in other words: "no regret"

The scenarios	Slow peak	The long goodbye	Critical gas	Meet me in Paris
Consumer acceptance of EVs	↑	↑↑	↑↑	↑↑↑
Efficiency	↑	↑↑	↑	↑↑↑↑
Competition between gas and renewables	↑↑	↑↑	↑	↑↑↑↑
The future of nuclear/coal	→	↑	↓	Nuclear ↑ Coal ↓
Concentration of economic growth	Developing countries	Neutral	Neutral	Developed countries

Meet me in Paris (the future is now)

Alternative energy becomes cheap enough quickly enough to displace existing infrastructure. Climate change becomes a top priority for governments around the world. Carbon trading with caps and bans on ICEs consistent with the goals of the Paris Accord are agreed to internationally and implemented quickly. Ocean pollution reaches the top of the international agenda, leading to regulation and outright bans on single-use plastics. Consumers lead the way with environmental awareness driving dramatic lifestyle changes.



The long goodbye — a renewable (r)evolution

Electric vehicles, distributed generation, renewable generation and battery storage take a place in the market suggested by falling costs. Oil demand peaks, but oil consumption from existing vehicles, consumer inertia and continued growth in segments other than road transportation (aviation, petrochemicals) keep it from falling off a cliff. Power demand grows steadily, driving steady, but muted, growth in natural gas demand, as nuclear power falls in cost and grows in acceptance. Oil and gas companies gradually migrate their capital from core businesses to alternative and emerging energy technologies.

Slow peak — business as usual

Continued upstream cost reductions muddy the competition between hydrocarbons and renewables. Transportation demand in developing countries surges and defaults to the incumbent technology (ICE), while consumer perceptions about EV performance slows electric vehicle adoption. Peak oil eventually happens, but not soon. Growing economies in developing countries drive demand for petrochemicals, energy intense industrial usage and aviation.

Critical gas — petroleum lives on, but it's gas and oil now

Oil demand peaks and tails off fairly quickly as consumers migrate from gasoline-powered cars to EVs. Power demand surges as EV charging takes off and developing economies electrify. Renewable, distributed generation and battery technologies progress as expected, but capital markets fail to respond with funding on the scale necessary to displace fossil fuels. Regulators don't allow coal and nuclear to grow with power demand, leaving the market open for natural gas-fired generation. Capital moves toward gas-focused upstream and LNG assets.

Before we dive into the detail, let's outline the main conclusions:

1

First, we agree that **peak oil demand is a likely outcome**. Road transportation is the single biggest source of oil demand, and vehicle electrification appears an unstoppable trend. Battery technology has advanced (and will continue to advance) to a point where EV cost and performance will soon be competitive with the ICE, as suggested in the EY Countdown clock model. More and more automotive OEMs are expanding their EV production, some even going as far as stating they may only offer hybrid or EVs in the near future. Known influences will get in the way of a fast end to the oil age. End uses for which there is no non-petroleum substitute (aviation, petrochemicals) are growing quickly, particularly in the developing world. There are also multiple unknowns that can either slow or quicken the transition, and it may take a much longer time than many believe for the oil business that we know to become a relic.

2

Second, **natural gas (in combination with renewables) has, so far, driven decarbonization**. Not coincidentally, it has also seen a dramatic shift in its pricing and return paradigm. Before hydraulic fracturing technology came along, natural gas was a lot like oil. The supply-demand picture (and prices) swung wildly as we shifted from scarcity to abundance. Now, it's more like a manufacturing business with an advancing technology. The shale resource is big enough that resource constraints no longer matter. Very little security of supply risk exists when a generating plant is powered with natural gas. As a result, we see significant upside for gas as a power generation fuel.

3

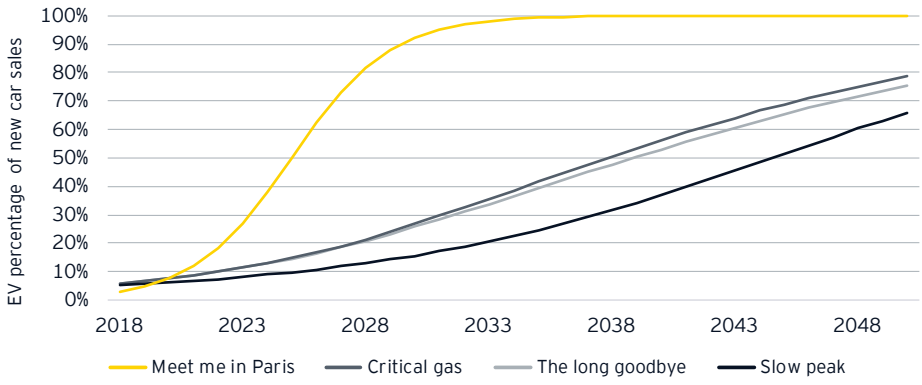
Third, notwithstanding any of this, **returns currently available hold up over a wide range of energy transition scenarios**. There are, of course, predictable variations, based on variations in demand, but it's our view that a dollar invested in oil and gas assets across the value chain today is still likely to produce fair returns. Execution matters and costs will fall. The greatest threat to the returns on an oil and gas investment made today is still likely to be the more efficient oil and gas asset of tomorrow.

Transportation, electrification and the role of oil

Electric transportation is an unstoppable force. We are close to the point where on a straight cost and performance basis, EVs will be competitive with ICE-powered vehicles. There's more to the equation than cost and performance. Consumers have gotten used to the way that they get around now, and a certain assurance comes with doing things the way that they have always been done. Change creates risk, real and imagined.

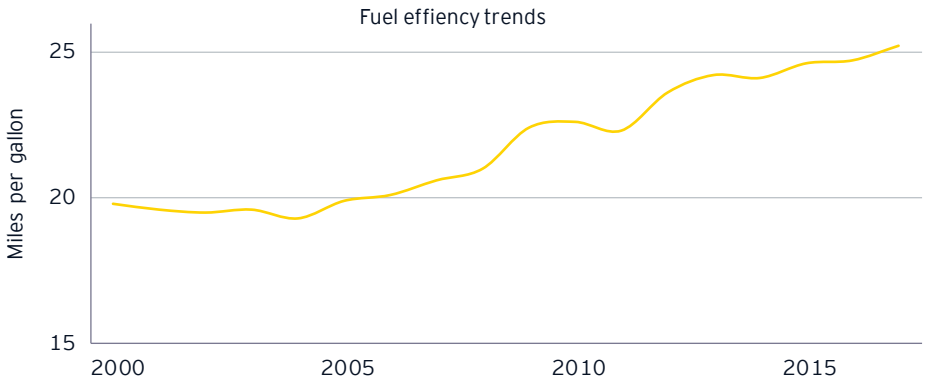
When it comes to EVs, we're optimistic, but there is still some uncertainty. We see two obstacles. First, it's not known how quickly consumers will become aware or convinced of the cost and performance advantages. Interestingly, if the technology is perceived to be advancing, many consumers may defer adoption and push the curve out. We also don't know how oil and gasoline prices will unfold over time. Drilling and completion technology is constantly improving. Costs are falling, and competition may bring lower liquid fuel prices. Second, significant investment still needs to be made building, at scale, the infrastructure required to charge EVs. There are as many charging technologies as there are EV manufacturers, and funding infrastructure can always be challenging.

EV adoption

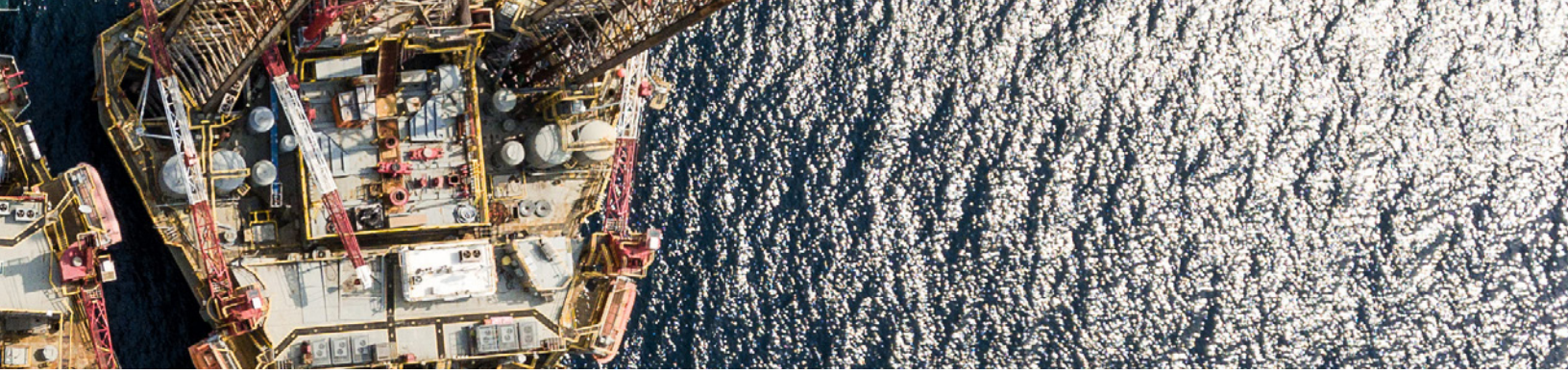


We've boiled down the various uncertainties to four potential adoption curves based on the timing of the transition from liquid fuels to electricity and the rate at which the transition occurs. We have a bias in favor of rapid adoption. The adoption curve in our long goodbye scenario is steep and the curve in our Meet me in Paris scenario, steeper still.

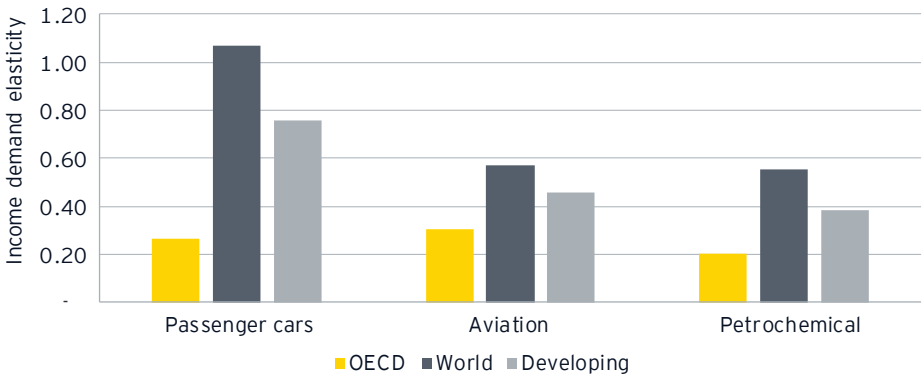
Once you've settled on the shape of the transition curve, even if it's a fairly steep one, the impact on oil demand will be muted at first. It will take time for the existing stock of gasoline-powered cars to fall away and be replaced. Conventional vehicles will still be on the road (and consuming gasoline) 20 or 30 years from now, and liquid fuels will be at least co-equal to electricity as a transportation fuel for the foreseeable future.



The other primary influence on oil demand is efficiency. The efficiency of automobiles has improved at a rate of about 1.5% since 2000. A lot of variables affect the efficiency trajectory, but it's mostly about the price of fuel, consumer vehicle preference (car vs. truck or SUV) and government efficiency standards, which we expect to ratchet up in response to decarbonization initiatives. Car manufacturers have a long list of measures on the horizon, waiting for standards or consumer preferences. Digitization, artificial intelligence and self-driving cars can be more precisely controlled from the perspective of fuel efficiency. Ironically, we expect competition from EVs to be an important driving force for efficiency. We expect efficiency gains to accelerate to something around 2% per year and have built that assumption into two of our scenarios.



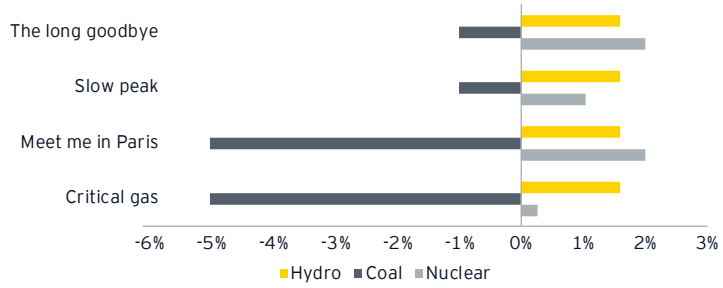
Petrochemicals, aviation and the developing world



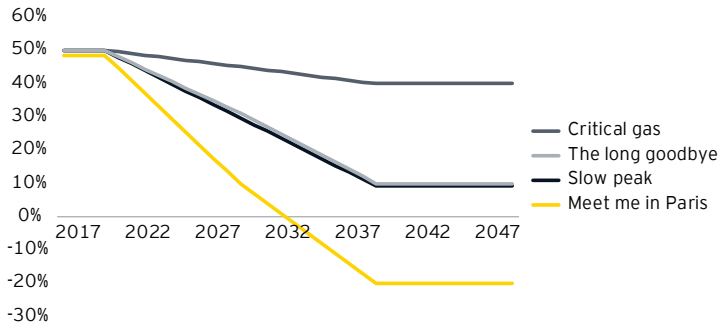
There's more to oil demand than road transportation, and most observers agree that the strongest growth (perhaps the only growth) in petroleum demand will come from petrochemicals and aviation. Both segments have no viable non-oil substitutes (although plastic recycling may be one soon) and both are strongly related to income. As developing countries develop, they will want to travel longer distances by air and own more manufactured goods that use plastics. We model the growth of these sectors as function of income, with the sensitivity varying from region to region. Consumption of almost everything energy-related (transportation, aviation and petrochemical) is more responsive to changes in income when income is lower, and our scenarios reflect this.

Power generation and natural gas demand

So, how will power be generated, and how will trends in the generation mix affect oil and natural gas demand? Together, nuclear and coal-fired power plants account for almost 40% of the world's electricity.



There's a fairly broad range of estimates for growth in coal-fired generation (anywhere from 1% growth to 4% shrinkage per year) and a fairly narrow range (about 1.5% pa) for growth in nuclear generation worldwide, with a lot of variation from region to region based on income (coal is still the fuel of choice in the developing world) and access to technology and capital to build nuclear power plants. We have a bias toward the lower end of the range for both. If climate change is to be arrested, coal cannot be burned in the volumes that it is today. Nuclear power is less likely to grow significantly outside of developing markets due to high upfront investment costs and public perception on safety issues, driven by events such as Fukushima. The resulting impacts are the exit from nuclear in countries such as Germany and the decommissioning of nuclear plants instead extending the life of existing assets.



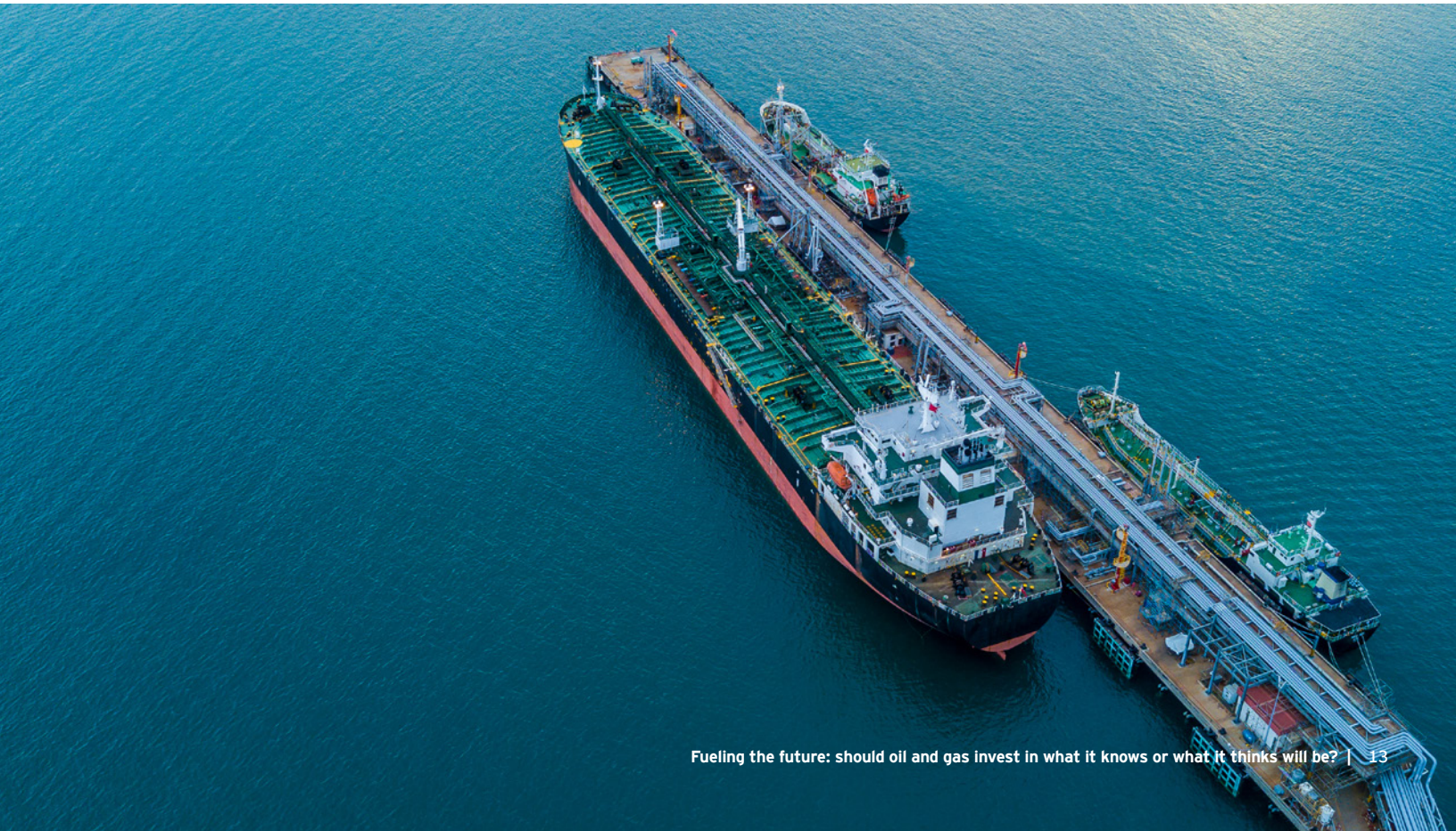
After you've accounted for demand growth and subtracted expected generation from coal and nuclear, the big question is how what's left over will be divided between natural gas and renewables. There's a big range of outcomes here. It could very well be that there's no competition at all. Distributed, renewable energy and the companion energy storage systems become competive quickly and may displace fossil fuel generation quickly.

We believe that there's a material risk that it won't turn out that way. Intermittent power, like most renewables, require some sort of backup. Batteries are an answer, but so is natural gas-fired generation. As renewable generation grows, we'll learn more about the relative economics. A big part of the renewable story is distributed generation. Financing rooftop solar (with battery backup) will require consumers to capitalize what has, thus far, been financed on corporate balance sheets backed by a regulatory compact. That process will take some financial innovation, and time. Subsidies have made all the difference to date, but government subsidies have limits. No one knows what will happen when subsidies disappear, and there are few examples of emerging industries weaning themselves off subsidies and standing on their own. As mentioned previously, drilling and completion costs continue to fall. Digitization is likely to create another move downward in price and make gas more attractive to generation.

A summary of oil and gas demand under our scenarios is below. A couple of details are worth highlighting.

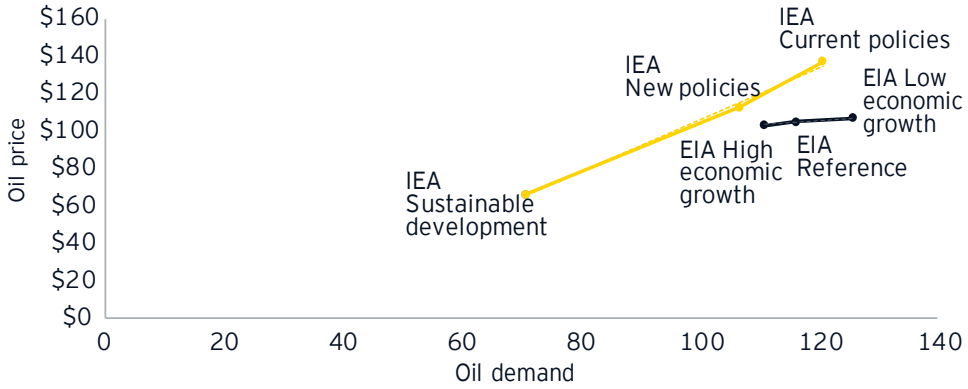
- First, non-transportation end uses are likely to put a floor of sorts under the demand for oil. Our scenario that aligns with the Paris Accord requirements never envisions demand falling by more than 2% in any given year. When you combine that with the natural decline in production, it means that under the most aggressive case oil exploration and production will still need to attract capital.
- Second, our Critical gas scenario envisions a more than doubling of global natural gas demand. The confluence of potential upside factors: rapid electrification, reduction in the role of coal, resistance to nuclear power, and technical and financial barriers to widespread penetration of renewables, leaves a potentially big role for natural gas at the margin.

	Slow peak	The long goodbye	Critical gas	Meet me in Paris
Year of peak oil demand	2047	2040	2037	2022
Natural gas demand growth (BCF/day)	268	285	613	42



Demand and prices

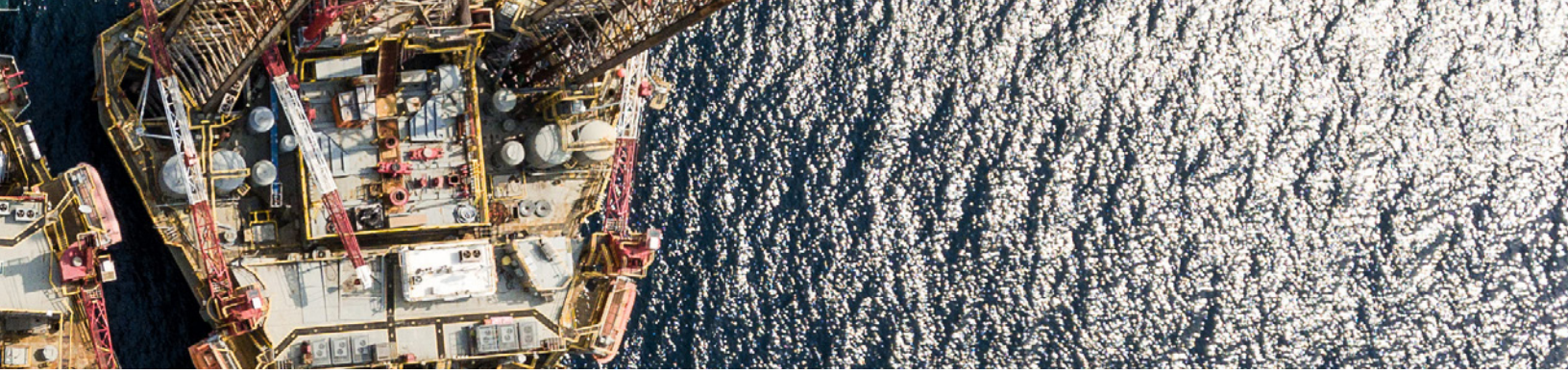
Forecasting commodity prices, especially oil and gas prices, has always been a challenging exercise, as a raft of factors can move the price away from what could be expected from a market-driven price discovery environment. However, to get to a view on the returns that will be available going forward, it is essential to have a view on how demand changes feed through into prices.



The easiest example to illustrate is the connection between crude oil and natural gas demand growth, the price of those commodities and the return on investments in upstream reserves. The multiple scenarios presented by the various agencies that are in the business of demand and price forecasting show a wide range of demand/price sensitivities.

To accommodate the range on uncertainties, the model we have used to determine potential returns can be varied to look at different price sensitivities.

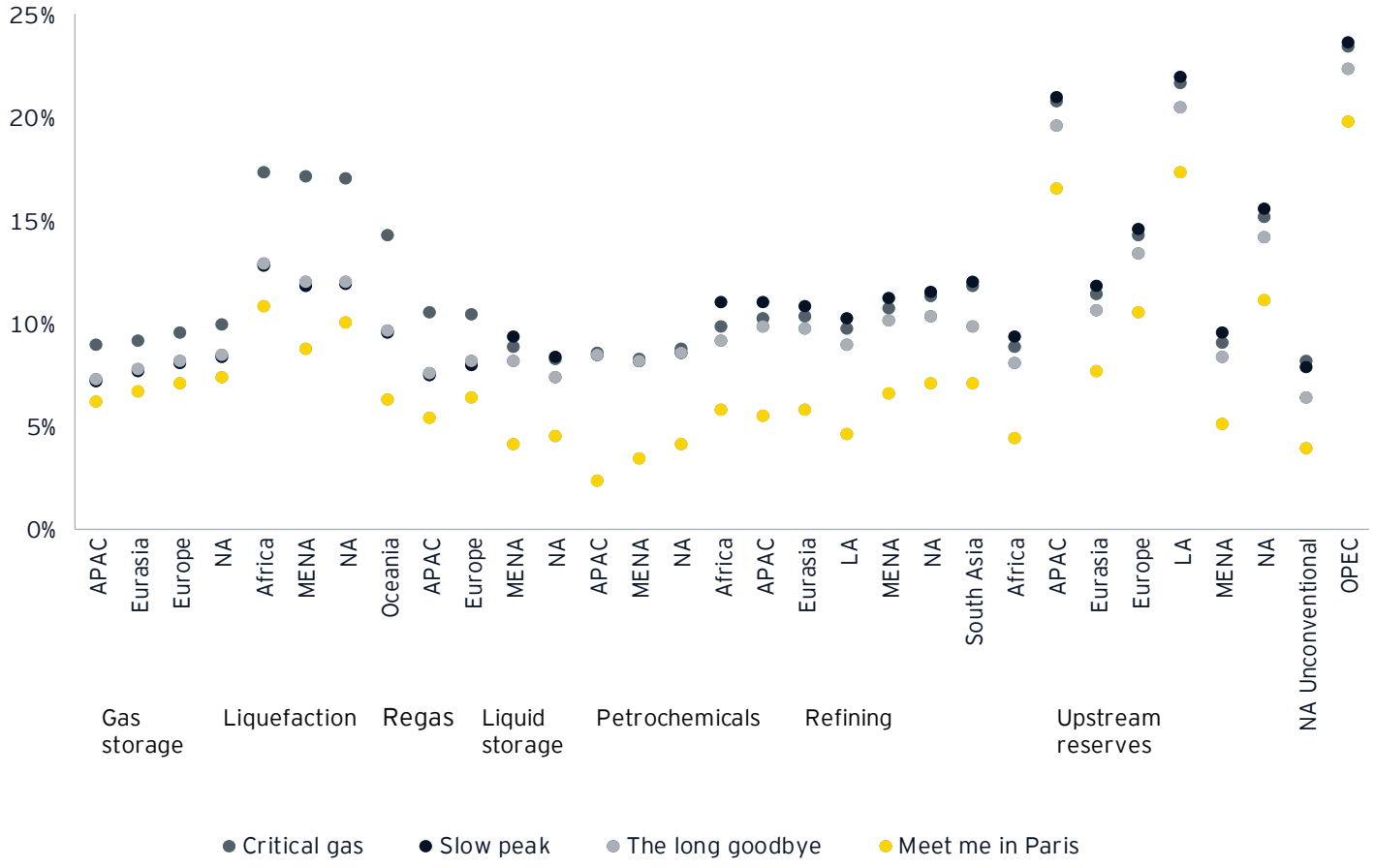
For the purposes of this exercise, we have used a price elasticity for oil and gas at the high end of the range produced by the price forecasting organizations, as this is more likely to capture the downside impact of declining demand.



Returns on oil and gas assets

The oil and gas business is many things, starting with the oilfield moving down the pipelines to the refineries, LNG plants and petrochemical plants. We've gathered the data on the cost of building and operating those assets and calculated the cash flows under each of our scenarios. The result of this is an estimate of the rate of return on each asset class.

The key takeaway from this exercise is that returns are, for the most part, appropriate in the context of the cost of capital deployed. Even in a Paris Accord-compliant scenario, it is still possible to envision returns, albeit ones that are low. The intuition around this is twofold. First, for most asset classes most of the impact to demand is currently projected to occur at a time when the effects of discounting overwhelm the price impact. Second, under any demand scenario, the industry will have to attract capital and offer competitive returns.



Chasing returns can be a tricky business, particularly if you're focused on what's going on now. The history of the energy business is replete with examples of companies that saw a big return on an asset class and invested heavily, only to learn that everyone else saw exactly what they saw and did exactly what they did. Prices in the relevant markets are competed away and returns disappear. Differential returns will self-eliminate (except with respect to risk) as capital flows to high-return segments of the value chain. Speed of convergence will depend on barriers to entry and competitive execution. Notwithstanding this, a first look returns are available and while volatility will always be an issue, the situation remains that assets that are efficient, flexible and in the right part of the cost curve will harvest the greatest share of the total returns available.

The no regrets strategy

In any commodity business, the biggest financial risk is the price of the commodity. Oil and gas are no exception, and the history of this business is full of episodes when supply overwhelmed demand, prices crashed and returns evaporated. We just watched one of those episodes, and there's no way to avoid the occasional regret when they happen.

Over time, though, supply and demand tend to even out. Our view is that, going forward, demand will be adequate to support many large (relative to other industries) players. What structural oversupply might come about from energy transition will only marginally affect the return on an investment made today (though this will change over time).

Today's oil companies have choices to make. They allocate capital; they recruit, train and organize staff; and they deploy technology to respond to customer needs and operate their businesses as efficiently as possible. Let's assume that oil and gas demand and returns follow the paths that we've laid out.

If they do, returns on oil and gas projects are likely to be competitive with, if not superior to, returns on alternative energy investments for some time. Also, given their skill sets, oil and gas companies will retain a competitive edge in oil and gas operations vs. other areas of the energy business.

However, there is a wide range of outcomes and smart companies will be hedging their bets. Smart portfolio managers do this by buying, developing and nurturing options. Major oil companies are already doing that; investments in the power sector (including traditional utilities), electric vehicle charging and renewable fuels are already in their portfolios.

History tells us that the most likely path for an industry with static or declining demand is consolidation. Economies of scale and scope are the best way to generate competitive returns, absent the potential for growth. If peak oil indeed is in our future, we can expect to see fewer, bigger companies.

However, in every scenario the "winners" will be those that achieve excellence in executing their portfolio and operating strategies. So, what are the elements of winning execution? We see these as:

- Maintaining a license to operate — HSE excellence remains critical here but so does engaging with the wider stakeholder community, including investors, whose objectives are changing and evolving
- Recognizing the early signals that will tell us if, and when, returns will be at their highest and putting together financing structures that reduce capital cost and calibrate risk
- High grading portfolios — taking a hard look at how much things cost and how quickly they pay back. Our intuition is that the trend of diverting balance sheet to shorter-cycle projects will continue
- Optimizing cost and capital efficiency — companies have always wanted to be on the low side of the cost curve, and tapering demand highlights that imperative. Heavy investment in digital technologies is a "no-regret" move, and winners will make the required investment to achieve improved efficiency and effectiveness
- Optimizing the profit from the molecules that move through the value chain — this will require a strong competency in trading, since no one has access to the best feedstock and product mix all the time. Effective and properly risk-managed trading requires investment in market intelligence gathering, process design and enabling systems
- Recruiting, retaining and motivating a workforce with the appropriate core competencies during structural change
- Making innovation work in a corporate environment.

We all know that the future of oil and the future of gas are very different narratives. For oil, the destination is understood, but the timing is uncertain. The opportunity for the industry to influence the outcome is limited and strategy will be focused on making the best of what will be.

Gas businesses have a window of opportunity to be market influencers or even market drivers rather than market takers. The competition between gas-fired power generation and renewable power generation will be about technology and financing. Much as they invested in refineries as the oil age unfolded, gas producers can make investments in advancing gas to power technology and bringing that technology to market. Oil and gas companies have a unique place in the world's capital markets and can use that position to promote the growth of the upstream gas business by facilitating investment into a new branch of the gas downstream.

Will those investments pay off? There is a lot of uncertainty, but here's what we'll be looking at:

1. First, we'll be keeping our eye on the government appetite for subsidizing renewable power and public pressure on governments to decarbonize the energy ecosystem. If that pressure eases, even a little, there's an under-appreciated opportunity for gas.

2. Second, we'll be looking at how the capital markets respond to the decarbonization imperative. Renewable distributed electricity will require a shift in financing from corporate balance sheets to consumer credit. If the credit markets can't enable that shift, there's also a window of opportunity for gas.

The core business lines of the oil and gas sector are going to be a key part of the energy mix for the foreseeable future. Not only that, companies in the industry can count on digitization to continue to drive down exploration, drilling, completion, production and refining costs, complicating the competition between fossil fuels and renewables. The footprint of the energy industry will change, and those changes will present opportunities for oil and gas companies to move their portfolio into new areas. Even so, returns will continue to be available in the traditional oil and gas business, and a continued focus on operational excellence can deliver a "no-regret" response no matter what future unfolds.

EY contacts

Contact us about this report.

Andy Brogan
EY Global Oil & Gas Transactions Leader
+44 20 7951 7009
abrogan@uk.ey.com

Gary Donald
EY Global Oil & Gas
Assurance Leader
+44 20 7951 7518
gdonald@uk.ey.com

John Hartung
EY Global Oil & Gas TAS Leader
+1 713 751 2114
john.hartung@parthenon.ey.com

Derek Leith
EY Global Oil & Gas Tax Leader
+44 12 2465 3246
dleith@uk.ey.com

Jeff Williams
EY Global Oil & Gas Advisory Leader
+1 713 750 5916
jeff.williams@ey.com

Author
Paul Bogenrieder, PhD
EY Global Oil & Gas Lead Analyst
paul.r.bogenrieder@ey.com
+1 713 750 4945

EY | Assurance | Tax | Transactions | Advisory

About EY
EY is a global leader in assurance, tax, transaction and advisory services. The insights and quality services we deliver help build trust and confidence in the capital markets and in economies the world over. We develop outstanding leaders who team to deliver on our promises to all of our stakeholders. In so doing, we play a critical role in building a better working world for our people, for our clients and for our communities.

The oil and gas sector is constantly changing. Increasingly uncertain energy policies, geopolitical complexities, cost management and climate change all present significant challenges. EY's Global Oil & Gas Sector supports a global network of more than 10,000 oil and gas professionals with extensive experience in providing assurance, tax, transaction and advisory services across the upstream, midstream, downstream and oil field subsectors. The Sector team works to anticipate market trends, execute the mobility of our global resources and articulate points of view on relevant sector issues. With our deep sector focus, we can help your organization drive down costs and compete more effectively.

EYG no. 005278-19Gbl
1910-3282687

ED None

ey.com/oilandgas