



A BOOMING SECTOR GRAPPLING WITH DIVERSITY, GLOBAL INSTABILITY, & CLIMATE CHANGE

A REPORT FROM THE
2019 ASPEN INSTITUTE GLOBAL ENERGY FORUM

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2300 N Street, NW | Suite 700
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Published in the United States of America in 2019 by The Aspen Institute

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EXECUTIVE SUMMARY

The global energy system is in a constant state of change. Prices and cost go up and down, geopolitical relationships ebb and flow, and technology and infrastructure are developed, deployed, and eventually retired. However, there are trends that have emerged over the last decade – including much greater U.S. oil and gas production and more investor and advocate pressure on companies with respect to sustainability – that have created a fundamental shift in the global energy system and that are likely to come into conflict with each other in the near future. The U.S. oil and gas industry is booming, particularly in the Permian Basin, but it is grappling with a diversity imbalance, a very unstable geopolitical environment, and a climate crisis that is affecting both its present and its future.

What producers and oilfield service companies have achieved in the Permian has been amazing, with the shale plays there proving to be far more prolific than forecast. The levels of production performance in the Permian, especially the amounts of associated gas, have led to bottlenecks in takeaway and export capacity as infrastructure struggles to keep up. Oil prices are likely to remain down in the long-term (though they will still be volatile), but it is unclear how sensitive U.S. production is now to price changes. The industry has innovated to become much more efficient, and improvements in cost structure have brought down breakeven points. Improved efficiencies, transformed cost structures, lower breakeven points, and transferred analytics and technologies from shale have likewise made other sources of supply – including onshore conventional drilling and deepwater – quite economic now as well.

All that said, the oil and gas industry has been a wildly negative cash-producing sector, leading the investors remaining in the industry to demand cash flow and greater capital discipline. The industry also faces lots of uncertainty about the future of demand, with population growth, economic growth, growth in transportation and petrochemicals, and extreme weather all pushing growth in oil and gas demand – but weakening global economic expansion (due to trade tensions and reduced manufacturing activity), carbon policy, vehicle electrification, campaigns against single-use plastics, and other factors countering these forces. Beyond softening demand, other risks to the sector's booming production include local impacts from development (e.g., water, land, noise, traffic, crime, schools, flaring) that could threaten the industry's local social license to operate, the risk of state regulatory constraints on production or practices (e.g., flaring), and political risk from the U.S. 2020 elections.

The industry is challenged by a lack of diversity too. The oil and gas sector is among the worst industries in terms of the percentage of women entering the industry and occupying seats in the C-suite. This is partly due to the industry perception that there are too few women in science, technology, engineering, and math (STEM), and some companies have sought to boost the feeder pool of talent by expanding opportunities for women in STEM, but the industry needs to bring in people with broader skills and backgrounds as well. The gender imbalance is also driven in part by unconscious biases in succession planning and promotions, leading some companies to reform their processes, force more diverse slates of candidates, institute more robust training programs related to unconscious bias, and expand mentoring and sponsorship opportunities for women. Another possible reason for the industry's challenge with recruiting and retaining women is that geographic limitations due to family concerns may limit some women's ability or desire to relocate to a field position. Companies may need to rethink what it takes to succeed and to rise, and they should strive to create a workplace culture that offers flexibility to women and men alike to manage family and work. Other workplace challenges require more attention too, such as ensuring female contributions in meetings. Women also need to take it upon themselves to be more assertive and to demand challenging assignments and promotions.

Ultimately, just like safety culture in companies, improving diversity requires the tone to be set at the top, continual attention, and everyone to share in making the change.

The oil and gas sector faces additional challenges from operating during one of the most unstable geopolitical times that some in the industry have ever seen. The United States has become a driver of global market stability, with the booming, short-cycle production growth in shale helping to offset supply disruptions, but U.S. trade wars and sanctions have at the same time become drivers of global geopolitical risk. Due in no small part to these U.S. policies and actions, China has been pursuing a new effort to reduce its dependence on oil and natural gas imports; its production may or may not change much, but other policies (e.g., related to electric vehicles) could reduce its oil demand, and it may shift its gas imports toward greater reliance on Russia. Russia is starting to position itself as the spiritual leader of the non-U.S.-controlled world and as a force to counter the U.S. “energy dominance” agenda, and it is mostly targeting the developing world’s energy demand growth. Russia has also joined OPEC, but the market power of OPEC+ remains unstable, and it is unclear how long OPEC will continue to ratchet down production as the United States increases production. Saudi attempts at market management misjudged the U.S. production potential, and the Saudi economy could take a hard hit if oil prices drop too low. In Latin America, meanwhile, more oil production is one of the few new economic growth opportunities available, with Brazil and Colombia potentially being more likely sources of growth than countries such as Venezuela and Argentina that are experiencing greater turmoil.

Climate change and the transition to a low-carbon economy will also have fundamental implications for the oil and gas sector. There is generally poor appreciation of the massive, systemic change needed to address the climate crisis; even as zero-carbon energy sources are growing, so are fossil fuel use and emissions. Energy demand growth, low oil and gas prices, infrastructure lock-in, income inequality, and other factors will make the clean energy transition very difficult to achieve, but the costs of climate change impacts and of not transitioning have to be recognized. The oil and gas industry is likely to be blamed for climate impacts and the lack of progress on climate change and climate policy. The industry should pursue technological solutions (e.g., to flaring and methane emissions) and make meaningful investments in technologies that could be long-term lifelines for the sector, such as carbon capture, utilization, and storage (CCUS) and direct air capture (DAC). In addition, it would be in the industry’s best interests to make climate protection a lobbying priority. Decarbonization policies are proliferating in regions of the world and in parts of the United States, and the politics around U.S. climate policy are starting to change, but getting a policy across the finish line may require active support from industry, as well as consideration of how carbon price revenues are used.

STATE OF THE OIL & GAS SECTOR

Oil and gas production is booming, and the industry has become much more efficient over the past few years. There are potential threats to continued production growth, though, including weakening demand, local opposition to production impacts, and political risks.

BOOMING PRODUCTION IN THE PERMIAN

What producers and oilfield service companies have achieved in the Permian has been amazing. The shale plays there have been far more prolific than forecast; some U.S. production companies have increased their resource size considerably based solely on new technologies and better understanding of the rock. Projections suggest 40% growth in U.S. crude production through 2025, which will increase exports from around 3 million barrels per day (b/d) to around 8 million b/d by 2025. Natural gas production is projected to grow from around 88 billion cubic feet per day (bcf/d) to around 115 bcf/d. Natural gas liquids (NGLs) are also expected to see significant production growth, going from 5.5 million b/d to around 8.5 million b/d by 2025. For example, ethane production is projected to grow tremendously, outpacing domestic petrochemical industry consumption, meaning more than a third of the ethane supply is likely to be exported. An even greater percentage of increased liquefied petroleum gas (LPG) production will likely be moving to international markets, as the U.S. market for LPG is somewhat flat. The booming production from shale suggests a need to find more international markets.

There are tremendous opportunities to use big data, machine learning, artificial intelligence, remote operations, and the like to recover higher amounts of oil from the existing rocks.

The production performance in the Permian, especially the levels of associated gas, surprised a lot of people, leading to some short-term bottlenecks in takeaway capacity as infrastructure struggles to keep up with growth. New pipes for gas should come into service in 2019 and 2020, though, which will help, and more are on the drawing board. With regard to crude, the market has responded, and pipeline projects are about to go into service; some believe the Permian will actually be over-piped. Still, to continue Permian development, infrastructure investment

of around \$200 billion per year is needed, particularly in export infrastructure to provide an outlet for the booming supply; at the moment, though, neither the country nor private equity is investing in it.

The surge in production in the Permian and other light barrel areas is leading U.S. refineries to move toward lighter barrels. This trend is being reinforced by the difficulty U.S. refiners face in accessing heavy barrels from some parts of the world due to sanctions and other hurdles, though more heavy Canadian barrels may begin to migrate to the Gulf Coast.

Even with all the production that has occurred, the Permian still holds a lot of exploration interest. Drilling is currently focused in the top-tier acreage, but well inventories are quite large, and there are several areas that still need

A NOTE ON ENERGY OUTLOOKS

FORECASTS IN THE ENERGY SECTOR ARE USUALLY WRONG. For example, a decade ago, no one saw the shale revolution coming. Long-term scenarios from different entities sometimes seem to be portraying entirely different future worlds. Energy outlooks, however, are not predictions. They draw on current data to flag risks and trends. Models are developed around extrapolation from past experiences. With a deluge of data, the inputs that create the model baselines are getting better and more reliable, providing a better launching point for extrapolation, but there is no accuracy to extrapolation.

In addition, multi-variable models are needed for anything beyond short-term forecasting, but it is impossible to know (or accurately factor in) all the variables. It is impossible to know exactly how human behavior will change, how technologies will evolve, how policies will develop, or how industries will self-regulate (e.g., due to shareholder pressure). Better forecasting, though, does not have to mean narrowing the windows of uncertainty; it could also mean more accurately assessing the range of uncertainty, even if those bounds are larger.

to be better understood. The industry has not yet pushed out to the edges, and it is unclear what the performance, decline rates, and so forth of wells in those areas will be. In addition, there are tremendous opportunities to use big data, machine learning, artificial intelligence, remote operations, and the like to recover higher amounts of oil from the existing rocks.

The Permian has become the benchmark against which others have to compete. While the Permian has become the focus of attention with respect to U.S. production, it was only a few years ago that the Marcellus and the Bakken were seen as being just as important. In the Marcellus, wellhead costs are now below \$1, which is phenomenal, but the Northeast is saturated with gas, and there is nowhere else for the gas to go; it is trapped. There is significant additional production potential in the Marcellus, but it is competing with associated gas coming out of the Gulf Coast and needs a price signal – currently lacking – that makes additional production logical.

LOW PRICES, HIGH EFFICIENCY, & IMPROVED COST STRUCTURE

Commodity prices generally go down over time. The oil and gas industry followed this path until around 1973 (i.e., the oil embargo), when it diverged from it and prices went up, but the industry has been and will be heading back in line with the trend. Brent crude reached \$85/barrel in October 2018, dropped to \$52/barrel in January 2019, and had an average price of \$66/barrel for the first half of 2019; projections for the second half of 2019 are for more of the same, and 2020 may be slightly lower. Oil prices are likely to remain down in the long-term. They will still be volatile, though, and the long-term declining trend does not exclude the possibility of prices occasionally hitting \$100/barrel.

Learning from shale, everyone is trying to do smaller, faster, short-cycle projects now, creating more opportunities to make strategic choices and dial up or down capital and activity. Still, it is unclear how sensitive U.S. production is to price changes. Prior to 2015, returns from drilled wells were highly exposed to commodity price fluctuations, but due to improved well forecasting and productivity, better anticipation of costs, revised cost structure, and other improved efficiencies post-2015, drilling activity is now much more robust to larger changes in price.

Learning from shale, everyone is trying to do smaller, faster, short-cycle projects now, creating more opportunities to make strategic choices and dial up or down capital and activity.

The overall trend is that companies are focused on bringing prices down, and cheap prices will have implications for fuel competition, energy and climate policy, and more.

Spurred by the low price environment in 2014, the industry innovated to become much more efficient. In 2008, it took the industry more than 32,000 people to produce 1 million b/d, while in January 2019, it took fewer than 13,000. (The downside of that efficiency is that workforce numbers are down since 2014, and greater digitization will drag those numbers down further. The perception of more digitized, technological, remotely operated work has made the job more interesting for some – often younger – workers, but older workers feel demotivated.) Drilling is also faster; a well that used to take 60 days now takes under 20, so an operator can do more wells with fewer

rigs, which means less capital needed for rigs. In addition, the industry can now do cheaper fracks, longer laterals, and higher recoveries from wells, and industry understanding of parent-child relationships, well-spacing, cube development, and more is vastly improved. In the Permian, development has become almost a manufacturing game, which means precision and execution to drive for the lowest costs. In an era of potential peak demand, companies want to be the low-cost producer, so efficiencies are continuing to improve. Technologies that bridge and blend digital and physical worlds could create further, unforeseen possibilities that enable even greater speed and efficiency.

The general cost structure has improved, bringing down breakeven points everywhere. The improved cost structure means that even with lower levels of investment in production, future supply holes do not appear to be on the horizon. The cost environment is also very different in the unconventional world than in the conventional in terms of where operators spend money. In the conventional era, a rig

accounted for half to two-thirds of total well costs, but a rig in the Permian today only accounts for about 4-5% of total well cost, whereas completion is about half the cost, with the rest involving facilities and flowback.

The overall trend is that companies are focused on bringing prices down, and cheap prices will have implications for fuel competition, energy and climate policy, and more. The losers from the lower costs are those in the supply chain, such as drillers and the larger equipment players. Between 2001 and 2014, there was heavy investment in oilfield services, with service companies bringing in hefty margins, but coming out of the price downturn, service companies have not recovered their pricing power, and they are unlikely to within the next couple of years. That component of decreased costs will be with the industry for a while. There is also still plenty of bloat in the service side globally, and investor pressure on services abroad could help bring those costs further down.

DEEPWATER & OTHER SOURCES OF SUPPLY

While shale is understandably the focus of attention, it is important not to lose sight of other sources of supply that are now quite economic due to improved efficiencies, transformed cost structures, and lower breakeven points. For example, when prices first came down in 2014, the general view was that offshore production was dead, but there is still a lot of value in deepwater. In 2014, the breakeven point for deepwater was around \$120, but it has come down tremendously; in 2018, it was around \$40-50 – and sometimes lower. A lot of the hard science and data analytics work that went into shale, such as subsurface modeling and completions design, is starting to be applied to companies' conventional reservoirs, with offshore seeing the most dramatic impacts. Seismic and advanced analytics are changing the game for exploration by boosting success rates, and reductions in cycle time from discovery to first oil are occurring as well. Most of the costs cuts in deepwater will be sustained; the dominant driver of cost efficiencies has been technology, which will be a lasting effect, while the softer prices from service companies are likely to be shorter-term. There will be a lot of production growth coming from offshore, and majors are investing substantially in offshore and deepwater, including in the Gulf of Mexico and Brazil. Governments are also starting to realize that companies need flexibility to react to pressures in the market and so are changing their terms, which will spur even greater international activity in deepwater. Some in the finance community, though, are less optimistic

about an offshore recovery over the next three to five years unless more governments change their fiscal policies or oil prices stay higher.

There will be huge additional onshore opportunities too. For example, the adaptation of science, analytics, and technologies developed for shale can impact a lot of conventional drilling in the Middle East. Even in the most developed areas in the Middle East, companies are finding additional reserves with new technologies. Onshore development in Egypt, for instance, benefited a great deal from high-tech seismic techniques. With all the new onshore and offshore supplies that can be developed, it is hard to see oil prices recovering much more than they have.

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INVESTORS & CAPITAL FLOWS

Internationally, there does not appear to be a broad-based market return in capex yet, though there is some investor interest in and capital flowing to liquefied natural gas (LNG). In terms of U.S. capital flows, factoring in the returns generated by the oil and gas industry, the amount paid on interest expenditures, and the amount spent in capex, the industry has been a wildly negative cash-producing sector, with greater than -\$40 billion in cash flow in 2018 and probably around -\$30 billion in 2019. In 2017 and 2018, the public markets put only single-digit billions into the industry, and public debt markets are not showing much incremental new leverage either. The result is low valuations for the industry in public markets. The performance of the energy sector in the S&P is down about two-thirds since 2014.

Investors are not investing capital because they are not seeing the returns, though returns are improving, with majors leading the way in generating cash flow returns; public independents are improving too. Investors in the industry are getting fewer, and those remaining are demanding cash flow and greater capital discipline. Many investors also have not been convinced that some companies' business models make sense, leading them to focus on dividends and discipline and to punish companies for longer-term or riskier ideas by selling stock. It remains to be seen if companies are willing to give up greater production growth to get more cash flow.

In terms of private equity (PE), there are various types of players in the energy space, ranging from occasional dabblers to pure-play energy firms. Fundraising for PE-backed energy is now way down too, with most energy funds raising less than half of expectations. It is clear that PE players will need to find a different strategy as they try to figure out the new norm. The successes that PE had in the early days of shale spurred the PE industry to overdo it, launching hundreds of exploration and production companies in North America, but many of the PE-backed firms now lack the financial capabilities, technology, or skillsets to maximize resource recovery and compete in the new market. Accordingly, there is an expectation that there will be massive consolidation in the PE-backed world; mergers and acquisitions activity is already growing, even if not as quickly as some think it should. There is a need for a more aggressive, unique, and creative model than the PE-backed companies have had thus far.

DEMAND

There is lots of uncertainty in the industry, including different views on the future of demand growth. On the one hand, population growth, economic growth, and extreme weather (e.g., more air conditioning to deal with heat waves) are all pushing growth in oil and gas demand. Many also expect continued demand growth from transportation and petrochemicals. On the other hand, there are reasons to question that continued trajectory.

It is unclear when peak demand might occur – potentially around the late 2030s or early 2040s – but there are many factors involved, including economic growth (which could experience lots of divergence from centrist forecasts), carbon policy, the electrification of vehicles, and the future of petrochemicals. With regard to economic growth, global economic expansion has weakened due to trade tensions and reduced manufacturing activity, and less economic growth means less oil demand. There may also be additional softening in demand in manufacturing, particularly in China, that is not yet widely visible or appreciated. In addition, climate policies could make fossil fuels less competitive, vehicle electrification could reduce demand in the transportation sector, and global concerns about reducing plastic waste and single-use plastics could create the potential for a sharp reduction in demand for petrochemical feedstocks. Likewise, decentralization enabled by technology could fundamentally alter the way markets function, especially in electricity, and the combination of changes in the grid (or people going off the grid) and new business models could lead to changes in demand that the oil and gas industry can barely fathom now. Assumptions about growth in energy consumption may also need to take into account changes in how the

next generation of consumers (the Greta Thunberg generation) thinks and consumes. Some feel that generation is far less consumerist and has far different preferences regarding sustainability, brands, and more, which could have implications for energy demand.

Population growth, economic growth, and extreme weather (e.g., more air conditioning to deal with heat waves) are all pushing growth in oil and gas demand.

With supply exceeding demand, demand growth has clearly become the main area of concern in oil markets. The markets have shrugged off what would have previously been serious incidents related to security of supply (e.g., conflicts in the Strait of Hormuz), whereas recent trade conflicts with China have elicited more reaction.

Still, even if electric vehicles make up half of new car sales in 2030, single-use plastics are phased out, and a carbon price is adopted, there will still likely be lots of oil demand. There could be major differences, though, in exactly how much oil demand, depending on how those factors play out, which could have implications for price and for longer-cycle oil development. Either way, given the decline rate for oil and gas reserves, a lot of new capital is still likely to be spent to produce oil and gas to meet the expected continued demand.

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OTHER RISKS FACING THE INDUSTRY

Softening demand is not the only risk. Local impacts from development, for example, continue to create challenges for the industry. Local communities tend not to talk much about climate change, but rather are concerned about immediate tangible impacts on water, land, noise, traffic, crime, schools, flaring, and other on-the-ground effects. Climate-focused opponents of fossil fuel development are therefore directing outside money to support local on-the-ground opposition, as that is where the greater sensitivity and grassroots resistance are.

There are serious problems looming, for instance, regarding the quantity of water produced, especially in the Delaware Basin, which will create real, very visible issues with water disposal. The technology does not exist now to properly treat and use the produced water, and it will not be possible to keep doing geologic injection at the needed rates. Projections of production growth may therefore be tempered by water problems until the industry as a whole learns how to do water recycling and disposal better.

Even in industry-friendly places such as West Texas, maintaining the local social license to operate is increasingly important. Social license to operate translates to permission – though maybe not endorsement – and requires operators to demonstrate shared value and broader benefits for communities. Upstream operators have the benefit

of making long-term commitments to communities, as workers are moving there permanently, raising families there, and otherwise building relationships and trust over time. Midstream companies, in contrast, are dealing with a very different set of variables and realities, as their investments and involvement in communities are not as long-lived and the direct benefits to communities not as obvious to see. This may be why the keep-it-in-the-ground movement has seized more on midstream than upstream.

Actual licenses to operate may also be at risk. With regard to Permian production, for instance, the Texas Railroad Commission is responsible for ensuring that the industry produces resources in a responsible way. Given excessive flaring, water disposal issues, and the amount of pressure on the city of Midland (e.g., education, unfilled jobs, stressed healthcare), there might come a day when the Commission decides responsible development requires slowing down permits or capping production. Some are skeptical, however, that the Commission will go back to some kind of price- or supply-managed world or will slow permitting. The Commission might take action on flaring – as flaring is increasing rapidly with the growing amount of associated gas that has nowhere to go – but there is skepticism it will ever put a quota on production.

The industry might face greater political risk in the United States from the 2020 elections. The projections of massive production numbers and the need for billions in export infrastructure could run headlong into positions that some of the Democratic presidential candidates have laid out, including proposals to ban new fossil export facilities, reinstate the fossil export ban, apply climate tests to all permitting, and limit or end further fossil fuel leasing on federal lands. Some of those will require action by Congress, but some could be done with executive power. Even if some of it is just rhetoric, it is already affecting investor perceptions. Energy policy may once have been politically boring and more regional than partisan, but it is not anymore. It would be risky for the industry to underestimate how real the political challenge is, how polarized the issues have become, and how far the policy pendulum might swing depending on the outcomes of federal and state elections.

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REPRESENTATION OF WOMEN IN THE OIL & GAS SECTOR

Across all industries, the oil and gas sector is at the bottom of the list in terms of the percentage of women entering the industry and in the C-suite. It is worse than Silicon Valley at tapping the pool of female talent.

THE STATS

Only about one-third of entry-level employees in the industry are women, and the numbers decline from there at every step through the ranks. There are two particular inflection points at which the industry loses a lot of women: the first promotion from entry-level to manager and the promotion from vice president (VP) to senior vice president (SVP). The SVP drop-off is especially notable; there appears to be a relatively clear ceiling. The ratio of women promoted to men promoted at each level is below 1:1 at the manager level, rises to above 1:1 at the director and VP levels, but then plummets at the SVP level. More women also leave the industry than men, especially at the VP and SVP levels. Half of the companies in the industry have no women in VP or SVP roles, and of those that do, more than half have only one (although there are differences across subsectors). Being the only woman in a boardroom or on an executive team often has a negative effect on that woman's performance; always being seen as the different perspective in the room can negatively impact her view of her own performance.

If the industry cannot recruit and retain half of the workforce, it is losing out.

The gender imbalance in the industry is mirrored in those that deal directly with the industry. The professional services sector that serves the industry, for instance, faces similar statistics and trends, as do some of the NGOs that work closely with oil and gas companies.

The data is sobering. If the industry cannot recruit and retain half of the workforce, it is losing out.

CHALLENGES & SOLUTIONS

One cause of some of the diversity challenges is the industry perception that there are too few women in science, technology, engineering, and math. Girls seem to be leaving advanced math courses in schools more than boys. For girls in middle school through college, STEM education is largely a highway with only off-ramps; once they get off (e.g., leaving freshman engineering programs), there are often no on-ramps back. Some companies have sought to boost the feeder pool of talent by sponsoring STEM summer camps, requiring some of the money they give to universities to be used for engineering scholarships for women and minorities, and the like. The industry's focus, however, should not be solely on STEM. Across technical male-dominated industries, and especially in the oil and gas sector, there is a strong perception that anyone (particularly a woman) who is not an engineer is not qualified, but it is far more important to find someone smart who can think critically and communicate well than to find someone

with an engineering degree. A lot can be taught on the job. If companies feel there are not enough women with STEM degrees, then they should look for other degrees. Bringing in people with broader skills and backgrounds can also introduce valuable perspectives that an engineer-centric approach can sometimes miss. In addition, some of those who have done recruiting within the industry have found that women who had parents in the oil and gas business were among the best prepared and have often been stars.

Unconscious bias is also at the root of some of the challenges. When doing succession planning and promotions, largely male managers may pick men with lower performance ratings instead of women with higher ratings without even being aware of it or having any ill intention. When thinking about who may succeed them, many tend to gravitate towards those who are most like them. Some companies observed that when only one out of five candidates on the slate was a woman or minority, that one had no chance of actually winning, whereas the chances improved somewhat if there were two out of five and improved dramatically if there were three out of five. These realizations have led some companies to reform their succession planning and promotion processes to correlate performance ratings with nominees earlier, to force more diverse slates of candidates, and to institute more robust training programs related to unconscious bias.

Related to this unconscious bias in promotions is an imbalance in the mentoring and sponsorship opportunities available to women compared to men. In response, some companies have started sponsoring young women to rise in the company – going beyond just mentorship to active advocacy for promotions, inclusion in important meetings, and participation in conferences that can increase their visibility. Meetings about long-term career planning are also important and empowering. Having mentors – male or female – asking a female employee to envision what she wants to accomplish can help her imagine a path for advancement, which in turn suggests that path is possible.

There are other ways, too, that the industry should rethink what it takes to succeed and to rise. For example, one possible reason for the oil and gas industry's challenge with retaining women beyond entry level and elevating them to executive levels is that geographic limitations due to family concerns may limit some women's ability or desire to relocate to a field position. The oil and gas industry wants leaders to cut their teeth in the field, so failing to do that can limit promotions. Women in the industry have also sometimes been counseled to go on the finance track (which tends to involve both less relocation and faster advancement) instead of the operations track, limiting the number of women with operational experience and thus the number in leadership.

Similarly, there is a need to ensure that women – and, really, all employees – do not lose earning potential when they take care of their families. Companies and organizations have to work hard to create a culture in which family demands are recognized and accepted and to create a workplace that offers flexibility to people to manage family and work. Organizations should strive for a culture where it is totally acceptable for anyone, man or woman, to take several months off or a less plum assignment for a while in order to manage a situation with a child or parent – without repercussions for their careers. The desire to balance work and family is not just a female issue, but progressive parental leave policies only work if men use them too; male leaders have to serve as an example, using and advocating for use of the policies. When people choose to leave the workforce to take care of family, the industry needs to find ways to welcome them back when they are ready, and some companies have started programs to encourage women who are ready to go back to work to rejoin the workforce. The macho culture of working non-stop, 24/7, has to change or the industry will fail to attract the best and brightest – female or male.

A workplace that is more conducive for women involves other elements as well. For instance, men seem to be trained or socially conditioned to jump into meeting conversations in a way that women are not, but having a voice in meetings matters. There are apps that can record how often men and women speak in meetings, which can provide data that highlights the problem of men interrupting and talking over women. Those running the meetings also need to

The desire to balance work and family is not just a female issue, but progressive parental leave policies only work if men use them too.

facilitate discussions to get a diversity of opinions and viewpoints, including ensuring that women have early opportunities to weigh in.

In addition, when women run into workplace challenges that border on harassment or discrimination but do not rise to the level of going to the Human Resources department, they need a vehicle for talking about and navigating it. There are many instances of women who have left the industry rather than be “the troublemaker” after facing a situation like that. Mentors and sponsors could be one avenue for discussion.

Responsibility for change falls on women as well. Women need to assert themselves more, demand promotions, demand challenging assignments that give them visibility within the company, and generally put themselves out there more. For instance, it appears to be rare for women to raise their hands for jobs they are not qualified for, whereas men do it all the time. Women have to be willing to say they want the job; that is the only way those who are hiring will know they do. This may be something of a generational divide; younger women today seem more willing to take the risk of going for positions where they cannot know ahead of time whether they will succeed. In general, though, women may benefit from training on matters such as how to go through performance reviews and how to apply for promotions.

Solving these diversity challenges requires industry leadership to recognize the problems and be willing to address them. Just like safety culture in companies, improving diversity requires the tone to be set at the top, takes many years to improve, and requires everyone to share in making the change. It requires companies to see women as individuals and not representatives of their entire gender; if one woman does not work out in a position, it does not mean that no woman can do the job. Improving diversity also needs continual attention, as companies can make progress and then backslide. Attention might be better sustained by continuing to make the business case for diversity, looking at where greater diversity may yield better business results (e.g., profitability, safety performance). However, the industry, like all male-dominated industries, also has to be cautious that diversity programs do not act as a shield to addressing discrimination and bias. Sometimes, discrimination can be more pernicious when it is shielded by a smokescreen of inclusion, with concerns dismissed because of how “diverse” and “inclusive” a company says it is.

ENERGY GEOPOLITICS

Energy is in the midst of one of the most unstable geopolitical times that some in the industry have ever seen. Geopolitical risk feels more present today than it has in a long time, for both supply and demand. There are so many things happening in so many places, and one little trigger could start a dangerous chain reaction.

THE UNITED STATES

Energy is no stranger to being exposed to shocks from economics and politics, and it is good at adapting to them, but it is rare that something in energy shifts the parameters in which global economics and politics operate. The U.S. shale revolution has done that.

The United States is now the largest producer of oil and gas in the world, and that will not change any time soon. This has had a range of impacts on the United States, including providing cheap and abundant feedstocks for the U.S. petrochemical industry and making the country more independent (though not fully independent) of energy imports. It has also, though, had a range of impacts in the global arena. Shale changed the number of oil supply powerhouses in the world from two to three: the United States, Russia, and Saudi Arabia. (The demand powerhouse is China.) The country that matters the most right now, for better or worse, is the United States. Oil markets are global, but in the last few decades, the United States has rarely been more of a force on the supply side and the demand side than it is today. The United States is a driver of both global market stability and global geopolitical risk at the same time.

In terms of global market stability, continued U.S. production growth is helping to offset geopolitical disruptions in supply. The U.S. shale plays did not just change the world because the wells are prolific, but also because of the short-cycle nature of the production. It is now possible to grow U.S. production quickly without the risk of long-term commitments.

On the other hand, the increased energy independence that the shale revolution gave the United States also has opened up room for trade wars to address trade deficits (of which energy is now a much smaller part) and sanctions against oil-producing countries to address other concerns. The Trump Administration's increased use of tariffs and other protectionist measures is creating greater uncertainty in the global economy and contributing to weakness in oil demand, while trade tensions, sanctions, and the like are worrying the industry and creating hurdles to deal-making.

The United States is now the biggest global market manager because its sanctions programs (now 30 and counting) are taking oil off the market, including in Iran. Energy sanctions are here to stay, as the United States views them as an effective way of applying pressure. The fundamental viewpoint in Washington is that they are a relatively low-cost way of managing foreign policy problems, especially in cases where force is off the table and at a time where diplomacy, at least in the eyes of some, has been discredited.

The United States is now the largest producer of oil and gas in the world, and that will not change any time soon.

There is no strategy undergirding U.S. sanctions as a whole. This is somewhat peculiar to the Trump Administration, but not totally. There are lots of players in sanctions decision-making, in both the executive and legislative branches, so integration has always been a bit rough. Even within the executive branch, there have been disputes about topics like where pressure is most needed. The United States needs to do a better job of improving coordination and integration on how best to use the sanctions tool. In the long term, if the sanctions tool continues to be utilized unchecked, it will lead to the creation of alternative systems of payment and finance – ones that do not go through the United States at all. The system will reorganize, moving financial transactions to Europe, China, or elsewhere, which will make sanctions far less effective.

CHINA

China has been pursuing a new approach to energy security, reflecting an effort directed from the top of the system to reduce the country's dependence on oil and natural gas imports. These efforts by China, the largest oil and gas importer, are driven in no small part by U.S. policies and actions (e.g., trade wars, export bans, secondary sanctions) that have led Chinese leadership to see the United States as an unreliable supplier of inputs to the Chinese economy and as an obstacle to other countries providing those inputs.

The Chinese government is trying to grow domestic production and increase energy self-sufficiency, including via subsidies for shale gas production and relaxation of joint venture requirements for foreign companies. The effort may not move the needle much, though, as companies will not be able to produce what is not in the ground. Also, while China has the largest technically recoverable resources of associated gas, the biggest lesson of the U.S. shale revolution is the role of competition. China's top-down approach does not particularly lend itself to competition, so shale in China may be decades away.

The longer the U.S.-China trade war goes on, the more beneficial it will be for other major gas exporters, with Russia likely being the largest beneficiary.

China may be able to slow the decline of its domestic oil production, but reducing imports will require action in other areas, such as policies to further reduce the use of oil in the transportation sector (e.g., by promoting electric vehicles or reducing car demand). Likewise, China may be able to squeeze a bit more natural gas out of the ground, but the intense gasification campaign the country is pursuing raises skepticism that gas imports will be reduced substantially. China may, however, shift the balance between pipeline and LNG imports. Even if its trade war with the United States is resolved and American LNG returns to the table, China will not want to

be too dependent on the United States, so it is worth watching whether another pipeline (e.g., from Russia to China) gets developed. The longer the U.S.-China trade war goes on, the more beneficial it will be for other major gas exporters, with Russia likely being the largest beneficiary. In addition, it will be interesting to keep an eye on the pace at which China develops infrastructure to direct natural gas into transportation, particularly trucking.

RUSSIA

Russia is starting to position itself as the spiritual leader of the non-U.S.-controlled world and as a force to counter the “energy dominance” agenda of the United States. This intent is evident in Russia's dealings with China, Iran, Saudi Arabia, Venezuela, and others. Russia is attracting plenty of new allies in its return to the role that the Soviet Union once played.

While other countries have their own complicated relationships with Russia, they feel pressed by U.S. actions on energy globally. Germany and northwestern Europe, for instance, feel offended by the way the United States has

put pressure on them not to build the Nord Stream 2 pipeline and to rely on U.S. LNG instead. There are sharp disagreements in the United States – within the Trump Administration and between Congress and the Administration – about what to do about Russia sanctions more broadly, and it is unclear if the U.S. Congress will actually pass additional sanctions targeting Russia. Bipartisanship over Russia sanctions is not as strong as it once was due to the Mueller report and the approaching 2020 elections. With regard to Nord Stream 2 in particular, even some sanctions hawks in Congress are worried about hurting the U.S. relationship with Europe and further souring European attitudes towards gas. Either way, the U.S. criticism and threats regarding the Nord Stream 2 pipeline feed a Russian narrative that the United States can block anyone's project and that Russia will protect all those producing energy or otherwise under pressure from the United States.

Russia's relationship with Europe, meanwhile, is filled with conflict and tension, partly because they have fundamentally different visions of the energy agenda. Russia is pushing oil and gas and nuclear, while Europe is pushing against all of those and instead wants more renewables, efficiency, and hydrogen. Russian leadership is recognizing that Europe is not a growing market; it will sustain it for as long as possible, but virtually all new pipelines and growth potential will likely be elsewhere, such as China, India, Southeast Asia, and South America. Russia is targeting the developing world's energy demand growth. The contamination of oil in the Druzhba pipeline will have consequences for Russian oil exports in Europe and will further push Russia's attention to the East. In addition, the transit agreement through Ukraine is expiring at the end of this year, but the parties in the negotiations remain far apart, and it seems like Russia, Ukraine, and the EU feel no pressure to make a deal happen. It is possible that there will be a major interruption of European gas supplies as a result, which, while temporary, will further destroy the image of natural gas (especially Russian gas) in Europe.

Russia's relationship with Europe is filled with conflict and tension, partly because they have fundamentally different visions of the energy agenda.

Currently, Russian exports are higher than ever before, and oil and gas production is growing, due to measures such as ruble devaluation and tax breaks that helped Russia adapt to the current energy market environment. Russia has to decide how it will pursue a new investment cycle in the industry, and the long-term strategy seems to be to become a leader in the global LNG market and to pursue onshore Arctic development – as well as to become a leading provider of new nuclear technologies that involve fast-neutron, closed-cycle reactors that are much cheaper than conventional reactors.

The investment climate in Russia, though, has deteriorated over the last couple of years, and the economy is shrinking. The elites are fighting over a smaller pie and are destroying the whole investment climate in a race for additional revenues and cash flow. Russia may still be a good long-term investment; major companies would benefit from having some presence there, but not a large one.

While Russia has a lot of internal problems, it should not be underestimated. Russia is very skilled at advancing and coalescing others around a new ideology for the world. Russia sees itself as excluded from Europe, wants to be a country to be dealt with, and is taking advantage of a world in which the United States appears to be giving up its leadership.

OPEC+

The more formalized relationship between Russia and OPEC and the boom in U.S. production will likely change how the United States thinks geostrategically about OPEC going forward.

In 2013, OPEC controlled 40% of global oil production, which was not enough market power. OPEC needed more, and the fact that OPEC felt the need to add Russia to form OPEC+ is indicative of OPEC feeling weaker.

When Russia joined, OPEC+ controlled around 60%, which worked well to drive prices up. With Iranian and Venezuelan production cuts, though, OPEC+ market power is again low and could be in the 40% range by the end of the year. OPEC+'s market power therefore is not that stable. Efforts are now focused on trying to lock members into lower inventory targets, but OPEC+ is challenged by trying to maintain a price floor that is higher than the direction the global market is heading. It is unclear how long OPEC will continue to ratchet down production as the United States increases production. Tensions between Russia and Saudi Arabia are increasing, and Russian oil companies are pushing back on production cuts out of concern that they are just helping U.S. shale producers. If oil prices go and remain low, OPEC+ members will not remain on board with those prices and production cuts. Increased cooperation is also unlikely because market instabilities (e.g., the U.S. sanctions on Iran and Venezuela) have been beneficial to Russia and Saudi Arabia, and Russia at least may try to continue provoking them.

SAUDI ARABIA

Most of the Saudi assumptions about where the markets would be now have proven to be wrong. Their attempts at market management misjudged the U.S. production potential; the Saudis were anticipating a supply gap that has not materialized. With the U.S. sanctions taking a fair amount of oil off the market, one would have expected Saudi production to rise from where it was a year ago, but it is actually lower than it was then.

Senior people in the Ministry have no illusions about the scope of the challenge; while their public remarks express confidence that U.S. shale will peak, plateau, and decline, internally they are expecting U.S. production growth of about 1 million b/d every year over the next few years.

The Saudis, however, have less fiscal flexibility now than they did two years ago to deal with a price downturn. The Saudi economy has recovered, contracting is up, and oil revenues are up, but the non-oil sector is growing at less than 2%, and Saudi unemployment is rising at the same time that 2 million foreigners have moved out of the country. To get to budget neutrality, the Saudis need a mid-\$80s oil price; they would probably get by in the \$70s, and at a \$65 price, they might manage to muddle through. If the price gets down into the \$40s, though, it gets to the point where the drawdown is too great, the economy takes a hard hit, and tough political choices

will have to be made. It is not just Saudi Arabia. Unlike Russia, countries in the Middle East have not made great macroeconomic strides to deal with lower oil prices, which makes the region very vulnerable.

That is part of why the Saudis have focused so much on Russia. The increased Saudi dependence on Russia creates leverage for Putin in the Middle East, at the same time that the U.S. Congress is pushing back against the Saudis for the murder of journalist Jamal Khashoggi and that President Trump is questioning why the U.S. is defending sea lanes in the region. The shale revolution affected American thinking on security in the region, though there is more partisan polarization in the United States than usual on what the U.S. approach to the Middle East should be.

LATIN AMERICA

The Latin American region as a whole is experiencing very low GDP growth, with only 2.5% growth projected for the next 5 years. That is quite low by Latin American standards, especially after the commodities boom that saw high growth rates and improvement in living standards. There are therefore many conversations about new growth opportunities for Latin America, and more oil production is one of the few available. For those countries with reserves, oil production is low-hanging fruit that can be achieved relatively quickly, and one can expect the Latin American region to be contributing more barrels.

Unlike Russia, countries in the Middle East have not made great macroeconomic strides to deal with lower oil prices, which makes the region very vulnerable.

Venezuela is where many think the region can increase production the fastest, but that may not be the case. While U.S. sanctions in Venezuela may be at a high-water mark, with little left on the sanctions menu to deploy, the sanctions have had significant impacts on the country (e.g., severe contraction in imports of food and medicine), and many people are leaving the country. President Nicolas Maduro has not folded, and there is a real sense that opposition leader Juan Guaido's moment has passed. There are conversations occurring between the government and the opposition about holding new elections, but the chances of reaching agreement are relatively low. Even if there is agreement, the best-case scenario involves a government transition in a year, after which the new government could try to present a law to the National Assembly changing the terms for oil production, after which companies might start thinking about investing in the recovery of fields and refineries there. Companies already in Venezuela will be positioned to act sooner, but increased production in Venezuela is still likely years away.

In Mexico, it seems that under the new government, the limited capex that Pemex has will be used for refineries instead of upstream, which means the declining oil production there will not be reversed within the next few years.

Brazil, in contrast, may be where the fastest increase in oil production is seen. President Jair Bolsonaro has demonstrated control over Congress, which means fiscal reform could be on the horizon, which could change some of the taxes affecting the oil industry. Brazil has said it will nearly double its oil production by 2025, and Petrobras is a credible actor.

In Colombia, companies have adjusted to lower prices and have a good amount of cash to invest. The major players will come back to Colombia, especially if there is an opportunity to do shale, which is the next big issue in the country. There is also some possibility of pursuing offshore natural gas development, though it requires investment and will depend on partners.

In Argentina, there is turmoil, and the elections will be decisive. The development of shale is moving forward, and companies are showing a strong appetite, but everything is on hold until the elections.

INTERNATIONAL MARITIME ORGANIZATION

The International Maritime Organization (IMO) has adopted requirements starting in 2020 that aim to reduce the sulfur content of marine fuels. They will be rather disruptive internationally, though not all agree about that. Wide price impacts are expected, with high-sulfur fuel dropping significantly in price (and perhaps going into power generation around the world).

The impact on the United States may be different than elsewhere. There was a political firestorm about the IMO rules and the potential that the Trump Administration might intervene to slow them, but it looks like the IMO rules will move forward. The United States has many complex refineries that are capable of removing the sulfur from high-sulfur fuels and/or blending with lower-sulfur fuels, whereas many other countries around the world do not. That is an opportunity for U.S. refiners; they still may not like the rules, but they have an economic advantage.

For those countries with reserves, oil production is low-hanging fruit that can be achieved relatively quickly, and one can expect the Latin American region to be contributing more barrels.

CLIMATE CHANGE

Climate change and the transition to a low-carbon economy will have fundamental implications for the future of the oil and gas sector.

CHALLENGES OF REDUCING EMISSIONS & TRANSITIONING TO CLEAN ENERGY

Massive, systemic change is needed to address the climate crisis, but there is generally poor appreciation of the magnitude of change needed. Renewable energy and energy storage costs are falling, electrification in transportation and industry is advancing, advanced nuclear technologies are making progress, and energy intensity is declining. Households are increasingly showing that they want to take steps to reduce their carbon footprints, as are large

corporations, which have been making substantial decarbonization commitments. Transportation companies are looking to further shift towards decarbonized fuels and vehicles. Investors are increasingly showing preferences for having climate risk somehow incorporated into data and analyses. Even with these trends, fossil fuel use grew last year, and global greenhouse gas emissions are still going up – at a faster rate than they have in a decade.

The history of energy generally shows that transitions occur only in terms of shares of the energy mix; when looking at *absolute* levels of usage, humanity never uses less of any particular fuel because the denominator of overall energy demand continues to grow. Currently, world energy consumption is projected to increase to around 740 quads by 2040, with the rate of energy demand growth accelerating in the 2030s.

Almost all energy demand growth will be in developing countries, which is also where most of global population growth and economic growth are expected. As the middle

classes in China, India, African countries, and elsewhere grow, they will likely be buying air conditioners, vehicles, and other energy consuming items, suggesting world energy consumption projections could well be too conservative. The historical patterns and future demand projections highlight the scale of the challenge of truly transitioning to zero-carbon energy.

Getting to a 2°C world – much less a 1.5°C world – will require more massive growth for renewables than seen for any energy sources ever, and that growth will have to be even larger given the need to pursue increased electrification of other sectors. Going to 100% carbon-free (especially based on variable renewable generation) could require a tremendous amount of generating capacity and storage, whereas significantly less of both would be needed if even 5% of the mix remained as fossil fuels (with CCUS). Bringing hydrogen into the mix would likewise reduce the amount of storage needed. Still, while there is a huge difference in how to achieve 100% zero-carbon versus, say, 80%, and a lot of time is spent debating how to achieve that last 20% of emission reductions (given the need to make infrastructure investments today), it is also worth recognizing that the world is barely making any progress in achieving that first 80%.

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There are many other factors that will make the clean energy transition very difficult to achieve. For example, the low oil and gas prices that are expected over the next several years mean that oil and gas will compete more strongly with renewables and other zero-carbon sources. Even though the cost curves for zero-carbon energies are coming down rapidly as well, it is far easier to move to a low-carbon scenario if oil prices are at \$100/barrel than if they are at \$50/barrel. Infrastructure lock-in is another challenge. For instance, U.S. LNG exports can displace more carbon-intensive sources and achieve near-term emission reductions, but they also lock in infrastructure for decades that may be incompatible with deep decarbonization targets. Societal polarization around growing income inequality will likewise make the energy transition more challenging, as it is generally consumers who will pay for the energy transition at the end of the day, which could lead to popular protests against measures to accelerate the transition. The yellow vest protests in France – which were about many things, including inequality, with a small carbon price on fuel being the final straw – could be just a drop in the bucket. Addressing climate change will come with costs that will be borne by someone – but the costs of climate change impacts and of not transitioning also have to be part of the story.

The low oil and gas prices that are expected over the next several years mean that oil and gas will compete more strongly with renewables and other zero-carbon sources.

The most likely scenarios in many outlooks involve continued robust use of oil, coal, and natural gas for at least the next couple of decades to meet energy demand. It is really hard to think about meeting global energy demand in a low-carbon way, but it is also important to recognize the climate impacts that will occur if it is not. To believe projections and outlooks that suggest that growing global energy demand will be met with fossil fuels is also to believe that people in 10 or 20 years will be as accepting of climate impacts as they are today and that there will not be abrupt changes in public demand for action (e.g., bans on some technologies, massive scaling-up of the “keep it in the ground” movement).

CHALLENGES & OPPORTUNITIES FOR THE OIL & GAS SECTOR

Climate disruption is already a fact, and it will get worse faster than many expect. The frequency and intensity of extreme weather events that impose hardships and suffering are shifting people’s perceptions of climate change from a future problem to something happening today. Communities are already starting to look at resilience planning and the budgetary impacts of resilience expenditures, and as those budgetary and human impacts dawn on more communities, people will start getting angry and looking for someone to be angry at.

The industry is looking at a world of growing future demand it feels it has to invest today in order to meet, but those levels of demand, if supplied by fossil fuels, are misaligned with long-term climate goals. If the industry is proposing a new gas pipeline, oil pipeline, or other fossil fuel infrastructure, the industry has to be able to justify it in the context of a society that within three decades will be net-zero-carbon. The industry has to explain whether it fits or is in conflict with that goal, whether the financial assumptions behind the asset are compatible with that goal, and the like. If the infrastructure is not compatible with the goal, then opposition from those aiming for a low-carbon future is understandable. Climate change is becoming more of a moral issue now. The industry can either engage in the process voluntarily, propose solutions, and make a business out of it, or it can resist. In Europe, the decision is to go green or go out of business.

While the focus on a net-zero-carbon economy by 2050 may sound radical to some in the industry, that formulation creates room for a combination of reductions industry makes, new technologies it deploys, and the capture of carbon from emissions sources or the atmosphere (either through engineered or land-based approaches). That creates an opportunity for those in the industry who want to be constructive in deeply reducing emissions to move forward. The industry needs to think about how to seize that opportunity and get ahead of the coming backlash. The industry has been demonized by climate activists and will continue to be unless it does something very different from the past.

On the technology front, the industry should start with the things it can do relatively quickly, easily, and visibly, such as addressing flaring. The industry also should find a way to go beyond regulations to get ahead of the methane emissions issue. The industry often declares that it is doing everything it can on methane emissions, but it is basically focused on satisfying existing regulations that require use of handheld cameras; the regulations do not consider industry's ability to use modern technology such as airborne detection and data analytics.

Some oil and gas companies, such as those in the Oil and Gas Climate Initiative (OGCI), are investing in new technologies – including carbon capture, utilization, and storage and direct air capture – that have the potential both to reduce emissions and deliver economic returns. These technologies could be life preservers for a continuing, albeit smaller, role for oil and gas in a zero-carbon economy. OGCI is an important initiative, with commitments from European CEOs and, now, some U.S. companies as well. The challenge for OGCI, especially as it expands its tent, will be to meet the expectations that people have for it to provide actions, investments, and policy support and not just words. The industry, for instance, needs to be investing heavily now in the infrastructure needed to make CCUS happen at scale. It is hard to get infrastructure built – especially in the United States – so if the industry is serious about having the infrastructure to capture, transport, and utilize or sequester CO₂ at scale, that will require a level of mobilization and investment that has yet to be seen from the industry, which risks making the industry's appeal to CCUS start sounding more like greenwashing.

The industry should start with the things it can do relatively quickly, easily, and visibly, such as addressing flaring.

While technologies are vital, oil and gas companies, which are full of engineers, risk being too technocratic in trying to address the climate crisis. Political and policy actions will be important both for actual progress and perceptions of the industry. For example, while there are always opportunities to improve regulation, the industry may want to rethink its stance regarding federal methane regulations. The Trump Administration and some industry groups are trying to roll back the Obama Administration's methane regulations, but if industry is cast as supporting the repeal of environmentally protective regulations, it will not have the credibility it needs to make positive changes in regulatory frameworks.

Similarly, the industry should consider making climate protection a lobbying priority – putting its political muscle behind an organized effort to accelerate climate policy development in the United States and directing its political contributions to politicians of both parties willing to take proactive stances on climate change. Many in the industry have thought that the slower that climate policy develops, the better, as it defers costs. The climate crisis, however, is not like conventional pollution; once it progresses to a certain point, all hell breaks loose, and it is harder to deal with. When climate disruption gets really bad, governments will not blame themselves; they will blame an easy target, such as the oil and gas industry. The lack of policy progress on climate change has also fed a lot of the sentiment spurring those trying to make it harder for the industry to operate by targeting permits, leases, infrastructure, and the like. A new generation of U.S. philanthropists is now directing hundreds of millions of dollars to fund the most radical, disruptive, in-your-face climate activists, so the industry should expect more of those, particularly if climate policy remains stymied.

European companies, such as the ones that founded OGCI, are ahead of U.S. ones in planning, in part because of European policy. European companies have been aware of carbon pricing for decades. Europe has long had emission reduction targets and sets them far in advance. European companies operate in a different policy playing field, encompassing renewables, energy efficiency, infrastructure, market design, biofuels, bans on single-use plastics, and more, all of which reshape company strategies.

Adapting is easier said than done. Industry is feeling some pressure to shift investments and actions to align with long-term climate targets, but few countries are acting as if they take those targets seriously, and if companies move too fast to invest heavily in solutions or engage actively in support of climate protection policies, they could be penalized by

their shareholders. Indeed, some companies in the industry are getting mixed signals from their investors. Investors still want the typical double-digit profits, but some also are putting pressure on companies to address climate risk and the low-carbon energy transition. Some investors have questions about the long-term viability and growth of companies that are not shifting much to address climate change, while other investors have questions about companies that are (e.g., whether oil and gas companies have the core competencies to become renewable energy utilities).

CCUS

Within the oil and gas sector, there is continuing work on CCUS to be applied to emissions from power and industrial sources. CCUS is real tech that is available now. Looking at the emission reduction curves needed to limit warming to 2°C, much less 1.5°C, it is clear that humanity will really need to dig in on CCUS and DAC; negative emissions will be necessary. CCUS will also be needed if zero-carbon hydrogen is to be produced from natural gas via steam methane reformation. Still, CCUS has been talked about for a long time, so some are skeptical that the situation is meaningfully different now and that the technology will actually take off and scale. However, in recent years, there have been some breakthrough technologies that look much more cost-competitive, some major policy incentives, and a lot more public and political pressure built up behind climate action.

While CCUS still seems to be nascent in the oil and gas industry and among investors, it is late in the game in terms of addressing climate change. If CCUS is to reach scale in a timeframe to make a meaningful difference, the technologies and supporting infrastructure (e.g., pipelines) have to be developed and implemented as soon as possible. If any industry could handle the thousands of miles of pipe and the geoscience involved in CCUS, it is the oil and gas industry. Service companies, for instance, have much of the technical capacity they need to engage in the CCUS space, given that most of the skills needed in the rest of the business are also applicable to CCUS. Service companies are only involved in CCUS in a small way, though, as the bulk of revenues come from upstream, and depressed margins limit their ability to invest in CCUS technologies. Because of the pressure on margins and the increased focus on a short cycle, even if long-term total system costs and carbon footprints are better with CCUS, investment will not flow there because there is no obvious short-term economic benefit.

Governments can both hinder and advance CCUS deployment. For instance, one issue in Europe regarding transporting and storing CO₂ is the need to overcome the protocol forbidding the dumping of waste at sea, which would limit the ability to store CO₂ in reservoirs offshore. Such reservoirs make a lot of sense, though. Making onshore carbon storage work in a way that is legally compliant and acceptable to the thousands of surface owners, mineral rights owners, and other stakeholders is hard. In addition, storing large amounts of anything in the ground can lead to collateral problems, as has been learned from injections of produced water, so governments looking to advance CO₂ storage with minimal opposition should consider offshore storage. For offshore storage to move forward off the East Coast of the United States, however, massive 3-D surveys will be needed to identify good geological storage sites, but such surveys generally are not allowed off the East Coast because they are seen as inviting oil and gas exploration. On the other hand, governments may also be essential to CCUS deployment, both because companies and investors will put limited funds into CCUS if policy commitments (e.g., stringent 100% zero-carbon targets) do not show a clear necessity for it and because policy incentives (e.g., the 45Q tax credits) can significantly improve CCUS economics.

Enhanced oil recovery (EOR) – in which carbon dioxide is used to boost oil production – can lay the groundwork for future CCUS efforts, including technical and infrastructure expertise. EOR has long been seen by some as an important gateway to developing the infrastructure, skills, and public acceptance needed for carbon storage. When EOR is done with industrial-source CO₂, the potential exists for the oil recovered to be carbon-negative; it appears that more CO₂ could be injected and sequestered than would be released from the combustion of the produced barrel of oil, though more analysis is needed. EOR has the potential to store millions and millions of tons of CO₂. (Of

EOR has long been seen by some as an important gateway to developing the infrastructure, skills, and public acceptance needed for carbon storage.

course, if EOR is done with natural-source CO₂, it does not contribute to carbon neutrality at all.) While EOR has always been focused on conventional reserves, there is also potential in the future to do EOR with shale, raising the prospect of permanently storing even more tons of CO₂ in unconventional wells. EOR using industrial CO₂ is not economically competitive on its own, though, given the costs of acquiring and handling the CO₂, so the economics of it are dependent on policies such as 45Q. There also has not been significant investor interest in EOR; investors

looking at pure economics are not compelled to invest (at least until the 45Q legal issues and guidance are sorted out), and sustainability investors do not see EOR as “sustainable”.

Carbon utilization is starting to expand beyond EOR. Many new products are still at the demonstration stage and need to scale, but American and Canadian firms (among others) are beginning to convert captured carbon into synthetic fuels, concrete, and more. Some strategies for utilization, however, are clearly better than others in terms of the carbon lifecycle – and some are just terrible – but there is not a clear set of understood criteria for what good utilization looks like. Indeed, some think the U in CCUS is unhelpful and unnecessary. If a CO₂ use permanently isolates CO₂ from the atmosphere, then that is storage (in a product), and if the use does not, then it is not particularly helpful as part of a deep decarbonization portfolio. Others think the U is significant to distinguish cases in which a higher government incentive is needed (i.e.,

geologic storage) from ones in which a revenue stream exists that allows for a lower incentive. Either way, clearer rules of the road on carbon utilization could help boost public acceptance of CCUS.

Indeed, public acceptance of carbon management – including use, transport, and storage – could be a key challenge. For instance, at the same time that 45Q got adopted, amendments were introduced to unwind regulatory protections designed to make sure that sequestration is done in an environmentally responsible way. 45Q passed due in no small part to the multi-year efforts of a diverse coalition of industry, labor, and environmental groups, but a key part of holding that coalition together was the inclusion of monitoring, reporting, and verification elements to ensure environmental integrity. The industry will struggle for sequestration to be accepted by the public if it also pursues a strategy of deregulating processes designed to ensure public and environmental safety.

Given the widespread distrust of the industry and their experience with fracking communications, it should not underestimate how its CCUS actions will be perceived by the public and the environmental community. For instance, while coupling EOR with DAC is technically equivalent to coupling EOR with industrial CO₂, some see a qualitative difference between pulling CO₂ from industrial processes (which helps industry decarbonize) and pulling it from the atmosphere in order to facilitate more oil production. There is already skepticism about CCUS among some on the left, who fear it empowers the oil and gas industry and allows the industry to continue with business as usual. Some in the industry think of the issue more in terms of where the incremental barrel comes from, preferring to have it come from a source with the lowest possible footprint; if the barrel does not come from U.S. DAC or EOR, it will not just go away, but rather will come from somewhere else (e.g., OPEC) with a higher footprint. That does not address the perception and distrust issues, though, and many in the environmental community would see a third potential option, namely to push hard to rein in and significantly scale back the oil and gas industry as a whole. What might get the broader environmental community to accept EOR and CCUS would be for companies to lay out, advocate for, and deploy meaningful capital to implement a clear plan that has stepwise reductions in the carbon intensity of oil, reaches net-zero by mid-century, and – as it is not possible to do CCUS to offset all of today’s oil emissions – acknowledges that total volumes of oil will need to go down.

While the oil and gas sector is the obvious one to advance CCUS, it is worth noting that other industries might also have technologies and business plans that can scale, such as those with deep chemistry, engineering, and industrial

gas expertise. Chemistry, for instance, is getting very sophisticated in its ability to encapsulate and turn carbon into dolomite, calcium carbonate, and other materials, so if chemists turn their attention to how to apply those skills to the atmosphere, it would not be too far-fetched for them to come up with a solution that could be applied cheaply over big areas.

In addition, while capturing carbon from the air can be done through mechanical strategies, it can also be done through biological strategies. The latter should not get overlooked by those more inclined to think in terms of technology and engineering.

TRENDS IN CLIMATE POLICY & POLITICS

There has been a substantial increase in the number of decarbonization policies in regions of the world and in parts of the United States. These include state actions (e.g., New York, California, New Mexico) to set economy-wide net-zero emissions and/or 100% carbon-free electricity targets. The policies to meet those targets are still in flux, but the targets have been set and represent a sea change from what would have been imaginable even five years ago. Even a year ago, the long-term goal being discussed was an 80% reduction in emissions by 2050, whereas now the focus is on net-zero by 2050. Outside groups, such as climate strikers and others, have been pushing politicians to make change, and the pressure is increasing. The dialogue on climate action is advancing at a rapid pace, and there is no reason to expect that pace to change, raising the question of what the targets and content of the climate conversation will look like in a year's time.

One sign of the shifting terrain in the climate action space is that carbon pricing is less central to some of the policy discussions occurring, such as the more expansive vision put forth by the Green New Deal. Still, many continue to view a carbon price as a vital driver of a clean energy transition. Carbon pricing is a climate policy that is robust against risk and uncertainty and that would help spur deployment of low-carbon and emission-reducing solutions.

Carbon pricing can take the form of a cap-and-trade program or a tax. While a tax dominates many discussions, cap-and-trade is still the major vehicle in the United States by which carbon is priced, though Canada is pursuing a national framework on climate change and clean growth that includes a carbon tax (with the national government mandating a carbon price if provinces do not adopt one). Either approach can be tweaked and adjusted to arrive at the same outcomes, but they are not identical for all purposes. For instance, from a global perspective, it appears to be much easier for different carbon markets to link up than to envision countries giving up sovereignty to achieve a common carbon tax.

Getting carbon pricing policies adopted has proven to be a difficult lift in many places. Getting policy over the finish line will require industry to be an active part of the push. There are numerous corporate dialogues and councils that now exist that are pushing for a price, and some companies are going to the Hill to talk about it. At the same time, some environmental activists are criticizing companies for only moderately (versus actively) supporting a carbon tax, which shows how expectations are evolving in the space.

Generating support for climate policy may also depend on how the revenues raised by the carbon price are used. In public polling, under half of Americans support a policy to reduce greenhouse gas emissions by taxing fossil fuels, but well more than half would consider it if the carbon tax revenue was returned as a dividend, and even more would support it if the revenue was invested in steps to address the problem, such as through investments in clean energy R&D. When trying to gauge climate policy support and implications, the devil is in the details.

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Some feel that climate policy efforts have involved too many economists and not enough political scientists, as the pricing frame is logical but does not work well politically for a lot of people. There are other policies that can send price signals, though, that may be more politically palatable; sometimes political feasibility increases when the price signal is masked. A clean energy standard, for instance, is a tradable performance standard that creates value for low-carbon electricity and can achieve many of the same gains as a carbon price in the electric power sector. A low-carbon fuel standard (LCFS), such as the one in California, similarly creates value in pursuit of decarbonizing transportation fuels. California's LCFS even includes DAC, and with the current LCFS credit price of \$190/ton, provides a serious price on carbon that can boost low-carbon technologies. Likewise, the federal 45Q tax credit created a \$50/ton incentive for permanently sequestering captured CO₂ and \$35/ton for CO₂ used for EOR.

Tax incentives and subsidies for low-carbon solutions can play a role in the early deployment of technologies, but the numbers would get awfully big when those technologies scale up and achieve mass diffusion. Technologies have to come down a learning and cost curve and become cost-competitive in order to be viable and truly substitutional in the longer term. Competitive markets and technological advancements can both play a role in achieving that.

The politics around U.S. climate policy are changing, and things may be at or approaching an inflection point. The Green New Deal has changed the political conversation, bringing climate change more front and center, while those opposing pipelines and other fossil fuel infrastructure have gained a foothold in the policy dialogue. There are fault lines within the left regarding the role of oil and gas, nuclear, and CCUS, as well as regarding the willingness to give something up (e.g., regulatory command-and-control) in order to get a deal to get climate policy adopted. On the right, the Republican mindset is beginning to shift, and more Republicans are stepping forward to speak about climate change, though the shift is not yet widespread. It is worth remembering that the current political impasse is not a permanent state of affairs; as recently as 2008, both major party presidential nominees supported action on climate change. In 2009, one party formed a bloc that opposed every step to address climate change – and has yet to pay a political price for it. For things to change, that party may have to pay a political price for obstruction.

Anything that will happen on climate change in Congress for the next decade will have to go through Sen. John Barrasso (R-WY), who will be either the chair or ranking member of the Energy or Environment and Public Works Committees. Companies, such as the big tech companies, that want to spur action on climate change should build energy-intensive data centers powered by solar and storage in Wyoming, as some are doing in Kentucky and elsewhere, to show powerful senators' constituents the economic promise of renewables.

In addition to reducing emissions in the United States, climate policy also needs to pay attention to some other important considerations. For instance, developing countries will have the biggest effects on greenhouse gas emissions going forward, so the United States should be cognizant of the implications of its actions and the potential for its technologies in the international arena. Furthermore, adaptation and resilience issues require much more attention, given the climate impacts that are already occurring and that are locked in for the future.

APPENDICES: AGENDA

FRIDAY, JULY 12

Opening Session

- Introduction** **Greg Gershuny**, Aspen Institute Energy and Environment Program
- Welcome** **Jason Bordoff**, Columbia University Center on Global Energy Policy
Vicki Hollub, Occidental Petroleum

SESSION ONE: **Data Room – Overview of the Global Energy Landscape and Emissions Reduction Strategies**

What is the current state and future outlook of the global energy market? How are statistics fluctuating in five- and ten-year forecasts? This session will explore drivers of global supply and demand and policies affecting the market.

Moderator: Jason Bordoff

Discussants:

- Linda Capuano**, EIA
Jay Pryor, Chevron Corporation
Chris Midgley, S&P Global Platts
Erica Downs, Columbia University Center on Global Energy Policy

State of the Oil and Gas Industry: Representation of Women in the Sector

Overview of new research on the representation of women in the oil and gas industry. What are the causes for drops in female participation and how to address these challenges?

Moderator: Vicki Hollub

Discussant:

- Kassia Yanosek**, McKinsey & Company
Janet Clark, EOG Resources

SESSION TWO: North American Oil and Gas

What are the economic and technical limits on rising North American production? What is the current and prospective impact of public and private equity investor sentiment? Will the gas resource base be sufficient to supply gas for decades at current prices, especially if gas associated with oil production peaks? What are the potential bottlenecks in midstream and export, and how are market participants and policymakers responding?

Moderator: Bill White

Discussant:

Neil Chatterjee, FERC

John Bookout, Apollo Global Management, LLC

Charif Souki, Tellurian Inc.

Randy Fowler, Enterprise

SESSION THREE: Policy and Public Uncertainties of Oil and Gas Development

How does the increasing importance of companies' Social License to Operate impact both policy and business practices? How are policy proposals promoting decarbonization perceived by companies and the general public, and what are the realistic policy options for climate mitigation? How can industry work with policymakers and other stakeholders at the local level to create mutually beneficial policies that aid the transition to a low-carbon economy?

Moderator: Jason Bordoff

Discussants:

Castlen Kennedy, Apache Corporation

Pat Wood, Hunt BEE Network

David Hawkins, NRDC

Tom Jorden, Cimarex

SATURDAY, JULY 13

SESSION FOUR: Global Oil and Gas

Global oil and gas market recovery and increased economic growth are expected for 2019. What are the key supply trends that would support this growth, and what is the impact of recent reserve discoveries? Based on the near-term outlook for GCC, Mediterranean, and Russian oil and gas, what are the future assumptions on price, particularly for offshore development?

Moderator: Vicki Hollub

Discussants:

Geir Westgaard, Equinor

Jamie Webster, Boston Consulting Group

Stacy Methvin, Pioneer Natural Resources

Peter Kagan, Warburg Pincus

SESSION FIVE: Geopolitical Uncertainties

Overview of the current geopolitical state, OPEC, and sanctions in Venezuela, Iran, and Russia. Can the US continue to apply pressure to these countries while mitigating effects to industry and businesses without disrupting the global economy? How do increased security risks, such as recent attacks on tankers near the Persian Gulf, impact diplomacy, oil prices, and the threat of military confrontation?

Moderator: Jason Bordoff

Discussants:

Tatiana Mitrova, Moscow School of Management

Daniel Sternoff, Macro Advisory Partners

Mauricio Cárdenas, Former Minister of Mines and Energy of Colombia

Richard Nephew, Columbia University Center on Global Energy Policy

Christof Rühl, Crystol Energy

Women in Energy Lunch & Hike – Leading Intentionally

A closed discussion with women attendees to address how women in oil and gas leadership roles can show greater intention to aid the energy transition.

SUNDAY, JULY 14

SESSION SIX: Creating Value for Carbon in a Carbon-Constrained World

A discussion about the actions and solutions needed by the energy industry for a transition to a low carbon future. How are technologies like EOR and CCS changing companies' priorities? What are industry strategies for reaching carbon emission reduction targets, and what are the impacts on business?

Moderator: Vicki Hollub

Discussants:

Richard Newell, Resources for the Future

Chris Kendall, Denbury Resources Inc.

Stéphane Lessard, Consul General of Canada

Lees Rodionov, Schlumberger

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