6-2017

How Oil and Gas Companies Can Help Meet the Global Goals on Energy and Climate Change

Lisa E. Sachs
Columbia Law School, Columbia Center on Sustainable Investment, lsachs1@law.columbia.edu

Nicolas Maennling
Columbia Law School, Columbia Center on Sustainable Investment, nmaenn@law.columbia.edu

Perrine Toledano
Columbia Law School, Columbia Center on Sustainable Investment, ptoled@law.columbia.edu

Columbia Center on Sustainable Investment

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

How Oil and Gas Companies Can Help Meet the Global Goals on Energy and Climate Change

Lisa Sachs, Nicolas Maennling, and Perrine Toledano

June 20, 2017

This briefing note draws from a project originated between CCSI, the International Finance Corporation, United Nations Development Programme, and the International Petroleum Industry Environmental Conservation Association.

Lisa Sachs is Director of the Columbia Center on Sustainable Investment (CCSI) and Co-Chair of the Thematic Network on the Good Governance of Extractive and Land Resources at SDSN. Nicolas Maennling is Senior Economics and Policy Research and Perrine Toledano is head of Extractive Industries at CCSI. The authors are grateful to David Kienzler, Nadra Rahman, Khyati Thakkar and Jacob Lipton for their assistance with this Briefing Note. The authors would also like to thank those who provided comments on the Consultative Draft published in January 2017.

Table of Contents

Introduction

In 2015, the world's governments adopted the 17 Sustainable Development Goals (SDGs), and a few months later, signed the Paris Agreement, which came into force in November 2016. These landmark agreements clearly lay out a global consensus on the need to curb human-induced climate change and to achieve sustainable development. These concepts are linked.[1] The urgency of addressing climate change is critical for global efforts to reduce poverty and advance sustainable development, but climate-change mitigation must also be pursued in a manner consistent with ending poverty, promoting economic development, respecting human rights, and ensuring social inclusion.

This has important implications for the world's approach to natural resource investments and to global energy provision. To date, no coherent vision has emerged to guide how global actors can shift the course of natural resource investments and the provision of energy in a way that leads to deep decarbonization and addresses the development needs of resource-dependent, low-income countries.

Solutions will require a tremendous amount of ambition, participation, and collaboration across society, including governments, international organizations, civil society, and the general public. Companies investing in the world's hydrocarbons also have a critical role to play. Apart from moral and ethical reasons not to destroy the planet for future generations, there are also practical reasons for companies to be involved. First off, the energy transition will create winners and losers. International Oil Companies (IOCs) that integrate climate change realities in their business models are more likely to play a role in continuing to meet energy demand in the future. Second, investors are increasingly conscious of climate change-related risks[2] with fossil fuel divestment and engagement strategies accelerating.[3] This trend is likely to continue, and IOCs that integrate climate change-related consequences in their strategies will improve their positions on capital markets. Third, companies that do not embrace a role that contributes to sustainable development will have trouble attracting a talented workforce given that millennials care about their employers' role in society.[4] Furthermore, the characteristics of IOCs are well suited to support the

[1] The climate actions communicated in the Intended Nationally Determined Contributions (INDC) of national governments have the potential to generate mutual benefits with at least 154 of the 169 Sustainable Development Goal targets. Eliza Northrop et. al. (2016) "Examining the Alignment between the Intended Nationally Determined Contributions (INDC) and Sustainable Development Goals (SDGs)"

[2] Extreme weather events ranked first in the World Economic Forum's Global Risk Report for 2017. "Global Risks Report," World Economic Forum (2017).

[3] For a history of shareholders' engagement, see CCSI's blog post "Shareholders Turn Up the Heat on Climate Change" (October 12, 2016). See also, "Exxon Mobil is trying to fend off a shareholder rebellion over climate change," Washington Post (May 31, 2017).

[4] "Millennials don't just want personal career growth; they expect to make a positive contribution to society. However, 14 percent of millennials say they would not want to work in the oil and gas industry because of its negative image – the highest percentage of any industry. If companies want to attract the best and brightest, they must design ways for employees to make an impact beyond the walls of the company." Christopher Handscomb et. al., "The Oil

energy transition. The sector is characterized by employing top engineers and scientists that help operate large-scale projects in difficult political and geographic environments. New energy solutions will require these skills and expertise. Moreover, the large balance sheets of IOCs, experience in significant up-front R&D and capital investments, as well dealing with large revenue fluctuations, give these companies an advantage in renewables markets which are not yet mature and see small-scale companies emerging and going out of business frequently.

This briefing note aims to summarize how IOCs can help expand access to affordable and clean energy (SDG7) and take urgent action to combat climate change and its impacts (SDG13).

The interrelated challenges of climate action and access to energy

The core aim of the Paris Agreement, which came into force in November 2016 and is incorporated into SDG 13,[5] is "to strengthen the global response to the threat of climate change" by "holding the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels." Economic and population growth combined with reliance on fossil fuels (coal, oil, and gas) have driven the increase in anthropogenic greenhouse gas emissions since the pre-industrial age. The resulting concentrations of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) in the atmosphere have contributed to global warming. CO_2 emissions, of which around 80% are from fossil-fuel use,[6] account for around 65% of all anthropogenic warming, with methane (emitted from fugitive gas and coal mining) accounting for another 17%.[7]

As noted in the Paris Agreement, achieving the limits on global warming will require achieving a "balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century."[8] This in turn implies a "decarbonization" of the energy system, meaning a shift from high-carbon to low-carbon energy (including carbon capture and storage technologies), as well as ending the net emissions from non-energy processes such as deforestation. According to 2013 estimates by the Intergovernmental Panel on Climate Change (IPCC), no more than 275 gigatons of carbon (GtC) (about 1,000 $GtCO^2$)[9] of the world's reserves of fossil fuels can be used this century, if we are to have a 66% chance of keeping global warming under

---

and Gas Organization of the Future," McKinsey & Company (September 2016). See also, "Oil industry struggles to fill hole left by baby boomers," Financial Times (October 28, 2016).

[5] SDG 13 explicitly acknowledges that the United Nations Framework Convention on Climate Change, under which the Paris Agreement was agreed, is "the primary international, intergovernmental forum for negotiating the global response to climate change."

[6] "Global Greenhouse Gas Emissions Data," United States Environmental Protection Agency.

[7] "The NOAA Annual Greenhouse Gas Index (AGGI)," National Oceanic and Atmospheric Administration (2016).

[8] "Paris Agreement," FCCC/CP/2015/L.9/Rev.1, Art. 4.1.

[9] The ~1,000 $GtCO^2$ is a 2011 estimate – Considering emissions of about 50 $GtCO^2$ per annum, the remaining 2017 budget is around 700 $GtCO^2$.

the 2°C threshold.[10] And yet, as of 2013, we had 746 GtC of known reserves, meaning that almost two-thirds of known reserves need to be left underground and be 'stranded'.[11]

Most projections forecast that fossil fuels will remain the dominant energy form, but these projections are inconsistent with the IPCC's recommendations, as they would result in global warming far above the agreed 2°C limit. These projections thus highlight the challenge that governments and the fossil fuel industry face to satisfy future energy demand while reducing emissions. All major technological approaches now on the table – energy efficiency, large-scale CCS, renewables, nuclear power, electric vehicles, and others — should be actively explored and will very likely have a role to play for some regions and some sectors of the world economy. And the world's governments, together with other international stakeholders, including companies producing fossil fuels, will have to determine what, ultimately, must stay in the ground.

The challenge of meeting energy needs without using abundant fossil fuel reserves is further complicated by the projected growth in world energy demand, which according to BP's 2016 Energy Outlook, is expected to increase by 34% by 2035. More than half of the energy demand growth is projected to come from power generation, particularly from countries with high population growth rates and lack of adequate electricity access.[12] As recognized in SDG 7, countries need plentiful, low-cost energy to run modern economies. Access to sustainable and modern energy is essential for economic growth, employment, education, poverty reduction, and health and safety. Without energy, the other SDGs cannot be achieved.

As of 2016, about 1.2 billion people had no access to electricity and an estimated 2.7 billion people – 38% of the world's population – had no access to modern energy sources, instead relying on solid fuels such as wood, charcoal, and animal dung for cooking and heating.[13] The reasons for this include people not being able to pay for modern energy supplies, populations living in remote areas, and a lack of public investment in energy infrastructure. SDG 7 calls for universal access to modern energy services (including a shift away from biomass for cooking fuels and other heavily polluting sources of energy), a substantial increase in the use of renewable energy sources (including wind, solar, hydroelectric, geothermal, and other zero-emission sources), and increasing energy efficiency.[14]

The enormity of the energy challenge should not be underestimated. Countries want to ensure that the transition to net-zero emissions will not sacrifice economic development, employment, and other social objectives. All countries and companies will

[10] "Climate Change 2013: The Physical Science Basis, Summary for Policymakers," Intergovernmental Panel on Climate Change (2013), p. 25.

[11] Richard Heede and Naomi Oreskes, "Potential emissions of CO_2 and methane from proved reserves of fossil fuels: An alternative analysis," Global Environmental Change 36 (2016), p. 12.

[12] "BP Energy Outlook," BP Global (2016), p. 13-17.

[13] "World Energy Outlook: Energy Access Database," International Energy Agency (2016).

[14] "Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all," United Nations Sustainable Development Goals.

need to plan for this integrated and balanced approach; the mass scale up of modern energy services should be consistent with the deep transformation of the world's energy system to net-zero emissions of greenhouse gases by the second half of this century. This is a daunting task, calling for judicious judgments and balancing of objectives.

Fossil fuel use in resource-rich developing countries

In cutting back on the global production and use of hydrocarbons to achieve climate goals, poorer countries should be given extra time and flexibility to overcome their energy poverty and their overall poverty. These countries have not contributed to climate change in the past, and the known reserves and projected demand rates in these countries will not have a large impact on the global carbon budget. In many resource-rich, poorer countries, the limited energy infrastructure that exists is generally designed around fossil fuels. Moreover, oil and gas can be a primary source of government revenues for other critical public expenditures.

The Paris Agreement acknowledges that achieving net-zero greenhouse gas emissions has to be done in the context of the priorities of sustainable development and poverty eradication, and so it does not call on developing countries to take on absolute emission reduction targets but rather to enhance emission mitigation efforts and to transition to economy-wide reductions over a time period that reflects their specific circumstances. This means that emissions reduction in high-income and upper-middle-income countries may have to proceed even more rapidly in order to give low-income and lower-middle-income countries more flexibility (e.g. a longer time horizon to make the transition to low-carbon energy) within the global carbon budget. The precise ways to give this added flexibility are still not globally agreed-upon, and the relative flexibility afforded to the poorest countries versus middle-income developing countries needs further analysis and elaboration.

Roles and opportunities for oil and gas companies

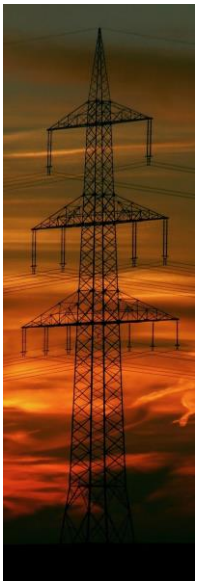
Oil and gas companies have critical and notable opportunities to help meet the world's targets for access to safe, reliable, and modern energy, both within their own business models and together with partners. First and foremost, each company in the industry should prepare itself for the transition to a net-zero emission energy system over the coming decades. With forward-looking plans, some of today's oil and gas companies will become tomorrow's highly diversified energy companies offering an array of net-zero emissions energy sources, using CCS and a wide range of non-carbon primary energy sources. The global path to net-zero emissions will require careful choices within each company on future investments to develop technologies and deploy new energy resources. Moreover, there are important opportunities for oil and gas companies to remain a dominant partner with the world's governments and other organizations to meet future energy demand and to help protect the planet. The following sections outline steps the oil and gas industry can take to prepare their businesses for the future, to strengthen efficiency and impact of current operations, and to leverage resources for broader partnerships and collaboration.

Long-term strategies for oil and gas companies

Strategic planning for a net-zero greenhouse gas emissions future

The Paris Agreement recognizes that countries need to conduct assessments of their vulnerabilities to climate change and undertake adaptation planning processes.[15] Similarly, there is a current need for oil and gas companies to develop a comprehensive understanding of the implications of climate change on their businesses.[16] Climate change has become a major systemic risk for business,[17] and it is even more so for oil and gas companies. Companies should leverage their well-recognized long-term scenario planning capacities to identify investment strategies and develop a transition plan to a net-zero greenhouse gas emission economy. These strategies would consider current resources, infrastructure investments, future fossil fuel demand, research and development, and current and future technologies.

The transformation will be a long process that will require long-term planning. The long operational lifespan of oil and gas infrastructure means that investments need to consider emissions scenarios 25-30 years in the future to avoid having to decommission equipment early or missing emissions targets. A growing number of companies are setting internal shadow prices on carbon emissions contained in the resources as a tool for screening projects and identifying impacts of a potential carbon tax, emission restrictions, or other reduction regulations in the future.[18] These different carbon prices ought to be incorporated into companies' investment decision-making, risk-assessment, and adaptation processes.[19]



Rather than react to external pressures, there is the opportunity to be proactive in creating and promoting energy-system pathways to meet the "well under 2°C" goal and pursue the 1.5°C goal. If companies help to lead that discussion, the industry will have more influence in shaping the process, including setting targets and identifying the policies needed for cost-effective, technology-based pathways to achieving the global goals.[20]

[15] "Paris Agreement," FCCC/CP/2015/L.9/Rev.1, Art. 7.9.
[16] "The Heat is On," Critical Resource (November 2015); "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015).
[17] "Global Risks Report," World Economic Forum (2017).
[18] "Effective policy: The driver of results (The Paris Puzzle)," IPIECA (June 2015); "Putting a price on risk: Carbon pricing in the corporate world," CDP (September 2015), p. 4.
[19] Examples of carbon prices used by companies: ExxonMobil: US$80/ton; Statoil: US$50-64/ton; BP: US$40/ton; Royal Dutch Shell: US$40/ton; Total: US$28/ton. "Embedding a carbon price into business strategy," Carbon Disclosure Project (2016).
[20] "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015), p. 23-24; "The Heat is On," Critical Resource (November 2015), p. 20.

Transparent and consistent targets, monitoring systems, and reward mechanisms to operationalize the strategy

Transparency around companies' policies, approaches to reduce emissions targets, resiliency strategies under different scenarios, key performance indicators and milestones would facilitate the implementation of the strategy. Transparency is also key to monitor progress and lead an informed discussion with other stakeholders that may have suggestions on how to further improve outcomes. Such an approach also increases the credibility of IOCs as actors interested in contributing to the transition.[21] Reward mechanisms for management should not only reflect financial results but also include compensation for the achievement of the targets set out in the strategy.

Natural gas in the energy mix

Natural gas can play a role in facilitating the broader integration of renewable energy into energy systems. The intermittency of some renewable energy sources such as wind and solar requires a reliable, complementary energy source that can be dispatched quickly to balance fluctuations in generation and demand and improve system stability.[22] Increasingly, intermittency will be addressed through improved storage technologies and regional integration of renewable energy sources. For the near term, however, using natural gas as the complementary energy source to address intermittency could assist the expansion and adoption of renewable energy.

There is also the possibility of developing new natural gas fields in some of today's energy poor regions, which do not have access to low-cost alternative energy sources, in order to underpin the scale-up of modern energy services for power generation, transport, and cooking fuels. This is especially the case in low-income regions that have recently discovered large reserves of natural gas, including in East Africa (notably Mozambique and Tanzania), West Africa, and parts of low-income Asia. These and other gas-rich but energy-poor countries should be allowed to develop their energy systems on the basis of their gas reserves, even if that will delay for some decades the transition to net-zero emission energy systems in these countries. These economies are too small and the known gas reserves too limited to have a major impact on overall global emissions, so that the worldwide trajectory towards net-zero emissions could readily accommodate the deployment of gas reserves in these specific low-income regions.

Moreover, when substituted for coal or other fossil fuels in power generation, transportation, and domestic heating and cooking, natural gas can help reduce emissions. We emphasize, however, that as natural gas produces significant CO_2 emissions when not accompanied by carbon-capture-and-storage (CCS) technology, a

[21] "Pathways to deep decarbonization," Deep Decarbonization Pathways Project (September 2015); "A post-Paris overview and analysis of BP's climate reporting," ShareAction (April 2016).

[22] "Natural gas: Into the future (The Paris Puzzle)," IPIECA (June 2015); "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015).

reliance on natural gas is not a general solution to climate change.[23] Furthermore, methane that leaks from gas projects is 100 times more potent as a greenhouse gas than carbon dioxide.[24] For this reason, the future global use of gas must be analyzed within the context of the long-term global energy strategy of achieving net-zero emissions by the second half of this century, as is needed to stay within the agreed limits on global warming.

Increasing deployment of alternative energies and new technologies, including carbon capture and storage

In 2015, renewable energy sources such as solar, wind, geothermal, hydropower, and biofuels accounted for more than half of all new power generation capacity.[25] They can also be a way to extend energy access in areas where there is low demand or small populations. In some cases, renewables may provide off-grid or micro-grid energy access in a more cost-effective manner than extending energy grids to these areas, while also supporting better health and environmental outcomes than the traditional use of biomass fuels.[26] Many oil and gas companies will find it advantageous to explore opportunities for research and development, and commercial investment in deploying alternative energy technologies. Some of the expertise and suppliers servicing offshore oil and gas platforms, for example, may be used and adapted for the roll-out of offshore wind farms.

One of the greatest opportunities for oil and gas companies to develop low carbon energy is through the development and deployment of large-scale CCS. Carbon capture and storage technologies reduce emissions by capturing, compressing, and then sequestering CO_2 in geological formations deep within the earth for permanent storage. CCS will be a key technology in the pursuit of lowering global greenhouse gas emissions. Industry collaboration with governments around the world on the research, development, and deployment of CCS would be vital to overcome the significant barriers to the large-scale deployment of CCS[27]; indeed, the oil and gas industry has the requisite expertise and global scale of operations to be in the position to test and implement large-scale CCS within a public-private partnership framework. The IPCC's 5th Assessment Report attaches considerable importance to CCS deployment with costs

[23] "The consumption of natural gas results in about 52 million metric tons of CO_2 for every quadrillion British thermal units. … In 2015, natural gas consumption was 81% higher than coal consumption, and their emissions were nearly equal. Both fuels were associated with about 1.5 billion metric tons of energy-related CO_2 emissions in the United States in 2015." Eliza Goren and Perry Lindstrom, "Energy-related CO_2 emissions from natural gas surpass coal as fuel use patterns change," U.S. Energy Information Administration (August 2016).

[24] "A Dirty Little Secret," The Economist (July 23, 2016); "The climate impacts of methane emissions," Environmental Defense Fund (April 2012).

[25] "Medium-Term Renewable Energy Market Report 2016: Executive Summary," International Energy Agency (2016), p. 3.

[26] "Toward a Sustainable Energy Future for All: Directions for the World Bank Group's Energy Sector," World Bank Group (July 2013).

[27] There are 21 large-scale integrated CCS projects in operation or under construction globally, with a combined CO^2 capture capacity of around 40 $MtCO^2$ per annum. For more details on CCS' large-scale operations, see "Large-scale CCS facilities," Global CCS Institute.

for delivering atmospheric CO_2 stabilization pathways without CCS shown to be much higher than when it is utilized, assuming that CCS can be deployed effectively at large scale. According to the International Energy Agency (IEA), to achieve a 450ppm scenario, CCS will need to capture and store some 52 GtCo² between 2015 and 2040, with 60% of this coming from the power sector and 40% from the industrial sector.[28] This scale of CCS mitigation would require global investment to grow from the few billion dollars already invested to an average of US$70 billion per year in the 2020s and US$110 billion per year in the 2030s.[29]

Support effective policy measures

An effective policy environment is needed to support the technology innovation, development, and deployment to transform the energy system at least cost. Countries at different stages of development and with different states of energy independence will decide how best to design climate and energy policy to pursue sustainable development as part of a global effort. Policies that give clear price signals on reducing net emissions, such as carbon taxes, often can help to achieve the policy objectives at low cost. A carbon price, through either a carbon tax or a cap-and-trade system, should ultimately aim to be global to avoid unequal international competition that would allow emissions-intensive businesses to move to less-regulated "emissions havens." Companies could support and encourage effective policy measures, such as a global carbon price, by sharing the industry's experience with such tools and engaging with stakeholders on policy issues.

Contributing to energy access and climate action at the operational level

Improving access to energy services through domestic gas allocation and shared infrastructure

Achieving universal energy access – including for the 2.8 billion people who currently do not have access to modern energy services – is a challenge both for the public and private sector.[30] Providing energy services is potentially a $37 billion market opportunity.[31] Many of those without modern energy access are located in developing countries where oil and gas companies have a long history of operating, giving them familiarity with local challenges. Companies can improve energy access by working with governments and local communities to determine how to best align their investments in a project with the country's and community's needs. If gas projects are developed with a view to service international markets, companies should work closely with the home

[28] Special Report on Energy and Climate Change, World Energy Outlook, IEA (2015), p. 105.
[29] Special Report on Energy and Climate Change, World Energy Outlook, IEA (2015), p. 116. By comparison, in 2016, the oil and gas companies of the Oil and Gas Climate Initiative (OGCI) pledged US$1 billion over ten years to accelerate the development of innovative low emissions technologies and CCS.
[30] "Energy for Sustainable Development," UN Sustainable Development Knowledge Platform.
[31] From Gap to Opportunity: Business Models for Scaling Up Energy Access," International Finance Corporation (2012).

government to maximize the opportunities for domestic gas allocation. Taking advantage of opportunities to develop shared-use energy infrastructure could also increase electrification around the project site.[32] Such investments should be compatible with long-term national and global commitments under the Paris Agreement.

Improving energy efficiency and mitigating emissions in operation and production

The extraction and transformation of hydrocarbons is a significant energy consumer — the oil and gas industry used 6.9% of the total energy it produced in 2011.[33] Improving efficiency in production operations and processing is one way to address energy poverty in both developing and developed countries, as well as reducing emissions at the point of production. Increased efficiency and reducing energy loss can reduce overall production costs, including in refining, processing, transmission, and distribution,[34] lowering retail costs as well. The industry could also explore the integration of renewable energy sources for their own power needs of operations.

Efforts specific to managing greenhouse gas emissions, particularly in the context of natural gas, can include:

Minimizing flaring: Five percent of the natural gas produced globally is lost to flaring every year. The flaring of natural gas can sometimes be necessary during the initial commissioning of a well or for safety reasons and generally companies have already taken action to reduce flaring in their operations. However, routine flaring, the burning off the associated natural gas during oil production, still occurs and wastes valuable energy. Options to reduce the flaring of associated gas include capturing it and using it for power generation, liquefying it for transport, or re-injecting it back into the reservoirs.[35]

Minimizing methane emissions: In oil and gas operations methane emissions can be the result of controlled venting or through leaks or escape in the various stages of the gas value chain. Companies can implement completions technology that captures gas released between drilling and production. Infrared cameras and continuous methane detectors used to identify leaks during production, processing, and transportation can also result in a substantial drop in methane emissions.[36]

Strengthening resilience and adaptive capacity to climate change impacts

[32] "The role of the oil and gas industry in tackling energy poverty," Accenture (2014), p. 9.
[33] Saahil Parekh and Siddharth Singh, "Towards an Energy Efficient Oil & Gas Sector," The Energy & Resources Institute (2015).
[34] "Saving energy in the oil and gas industry," IPIECA (2013), p. 6.
[35] "Zero Routine Flaring by 2030," The World Bank; "A Regulatory, Operational and Commercial Framework for the Utilization of Associated Gas," Columbia Center on Sustainable Investment (July 2016); "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015).
[36] "Managing our emissions: Energy conservation and beyond (The Paris Puzzle)," IPIECA (June 2015); David Lyon, "EPA Draft Says Oil & Gas Methane Emissions are 27 Percent Higher than Earlier Estimates," Environmental Defense Fund (February 23, 2016).

Climate change impacts are typically associated with warming and heat waves, but also include rising sea levels, shrinking of ice sheets and glaciers, droughts, floods, and more extreme storms, all of which may impact a company's infrastructure, assets, operations, and supply chains.[37] For example, rising sea levels may threaten offshore facilities or pipelines in coastal areas. Adaptation action is a key aspect of the Paris Agreement. Facility resilience is a key component of any company's risk management strategy. It requires identifying and evaluating a wide variety of risks, including those that may be influenced by climate change. Adaptation and management strategies can then be developed, implemented, and monitored.

Effective partnerships and collaboration

Partner in research and development and education outreach

Climate change will require unprecedented collaboration from all parts of society. Research is needed on current climate change issues and the future of the sector. New low-carbon technologies need to be developed and disseminated. There are opportunities for oil and gas companies to collaborate with universities and research institutions, governments, customers, and consumers to fill this need. These efforts can include public-private partnerships, joint R&D projects, and knowledge- and data-sharing through industry associations. Many of these efforts already exist, but greater coordination among oil and gas companies would take efforts to scale.[38]

Help suppliers and consumers to lower their emissions

Reducing the emissions of oil and gas activities is important, but only 10-20% of the total emissions from oil and gas comes from production and operations. The remaining 80-90% comes from suppliers and the end use of oil and gas products. Transportation alone consumes 60% of produced oil and is responsible for more than a quarter of global energy usage.[39] For this reason, many oil and gas companies are working with motor vehicle manufacturers to develop efficient fuels and advanced engine lubricants, and to introduce vehicles meeting stricter emissions standards. In addition to expanding this work, companies can also provide technical assistance to customers and conduct education and awareness campaigns for consumers to maximize the efficient and responsible use of oil and gas products and to transition to low-carbon systems such as electric vehicles and heat pumps for home heating,[40] as well as adopting more economical modes of transportation such as carpooling and car sharing.

[37] "Making the energy sector more resilient to climate change," International Energy Agency (2015).
[38] "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015); "The Heat is On," Critical Resource (November 2015).
[39] Ibid.
[40] "Pathways to deep decarbonization," Deep Decarbonization Pathways Project (September 2015), p. 9; "More energy, lower emissions: Catalyzing practical action on climate change," Oil and Gas Climate Initiative (October 2015).

An integrated, multi-stakeholder approach to energy poverty

Universal access to affordable, reliable, sustainable, and modern energy services will require the coordinated efforts of a range of stakeholders across different sectors. In addition to multi-stakeholder collaboration around the initiatives discussed above, additional efforts could focus on the following:

- **Creation of long-term energy access strategies that are consistent with net-zero emissions by the second half of this century (SDG 13)**: All countries need to move to low-carbon energy systems, though today's low-income countries should be given more time to do so in order to overcome energy poverty and overall economic poverty.

- **Creation of attractive investment climate for new energy services**: An environment that will attract a broad range of funding mechanisms is critical. There is a need for clear and consistent regulations, competitive terms, appropriate allocation of risks, and availability of credible buyers.

- **Creation of the right policy/regulatory framework that supports the development of both renewables and gas**: The Africa Progress Panel, among others, has recognized the partnership of gas and renewables, finding "the idea that countries in Africa have to choose between low-carbon development and economic growth is becoming increasingly anachronistic. … The smart money for the future is on natural gas and green-energy sources." [41]

- **Regional integration**: Not every country has low-cost renewable energy sources or natural gas resources, but every region does. Regional integration in renewable energy, and access to complementary natural gas, is a key step in power sector reform that would substantially reduce costs due to economies of scale. International companies working across countries within a region could help catalyze regional integration. Their ability to make cross-border projects work, including by finding cross-border efficiencies, can help overcome political obstacles and national competition and forge the path for political actors to achieve regional integration.

[41] "Power, People, Planet: seizing Africa's energy and climate opportunities. Africa Progress Report 2015," Africa Progress Panel (2015).

The Columbia Center on Sustainable Investment (CCSI), a joint center of Columbia Law School and the Earth Institute, Columbia University, is the only university-based applied research center and forum dedicated to the study, practice and discussion of sustainable international investment. Our mission is to develop practical approaches for governments, investors, communities, and other stakeholders to maximize the benefits of international investment for sustainable development, by integrating legal, economic, and policy expertise. We approach sustainable investment holistically, bridging investment law, natural resource management, human rights, economics, political economy, and environmental management. We conduct rigorous research, provide policy analysis and advisory services, offer educational programs, develop tools and resources, and foster multi-stakeholder dialogue and knowledge sharing among policymakers, development advocates, scholars, business leaders, and community stakeholders. We work to strengthen the sustainable development potential of international investment, and to ensure that international investment is mutually beneficial for investors and the citizens of recipient countries. http://ccsi.columbia.edu