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Oil and Gas Practice

The future is now: How oil and gas companies can decarbonize

As the pressure to act on climate change builds, the industry should consider a range of options.

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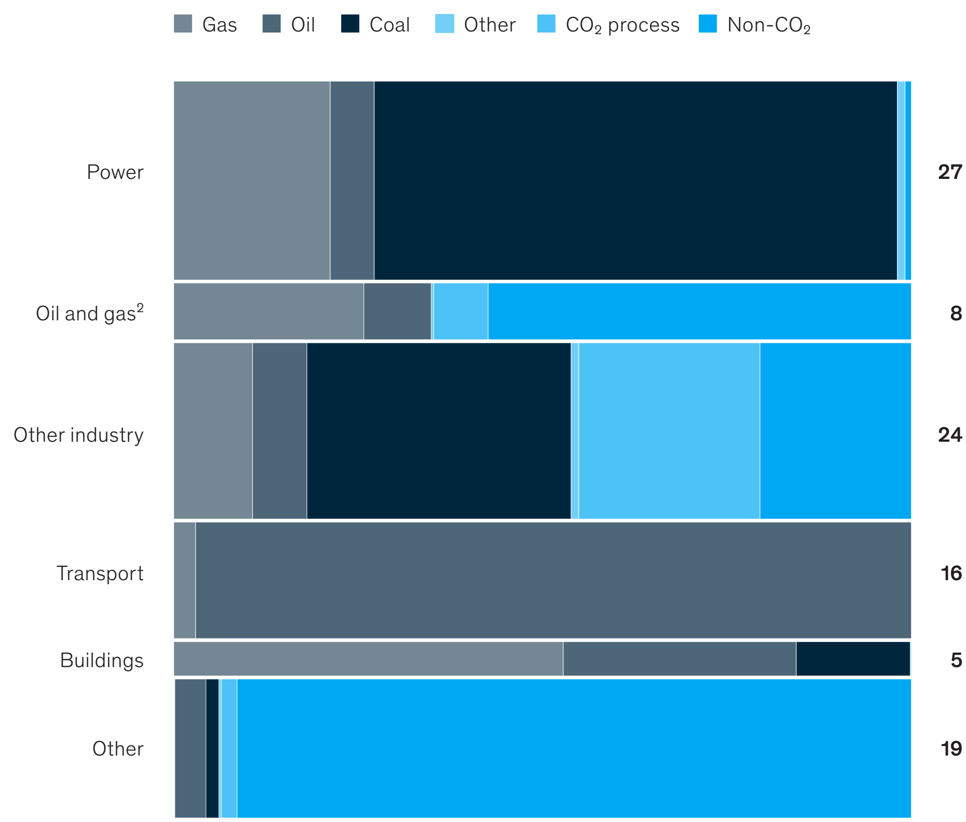
If the world is to come anywhere near to meeting its climate-change goals, the oil and gas (O&G) industry will have to play a big part (Exhibit 1). The industry's operations account for 9 percent of all human-made greenhouse-gas (GHG) emissions. In addition, it produces the fuels that create another 33 percent of global emissions (Exhibit 2).

Several trends are focusing the minds of industry executives. One is that investors are pushing companies to disclose consistent, comparable, and reliable data. Activist shareholders, for example, are challenging US- and Europe-based oil majors on their climate policies and emissions-reduction plans.[1] Investors are also increasingly conscious of environmental issues. In the five markets examined by the Global Sustainable Investment Alliance—Australia and New Zealand, Canada, Europe, Japan, and the United States—sustainable investments reached assets of $30.7 trillion in early 2018, one-third of total investment. At September's UN climate summit, an alliance of the world's largest pension funds and insurers (representing $2.4 trillion in assets) committed itself to transitioning its portfolios to net-zero emissions by 2050.[2]

Exhibit 1

Many sectors have to play a role if the world is to meet its climate-change goals.

Global emissions, by source and fuel type, 2015,[1] %



[1] Figures may not sum to 100%, because of rounding.
[2] Scope 1 emissions only.

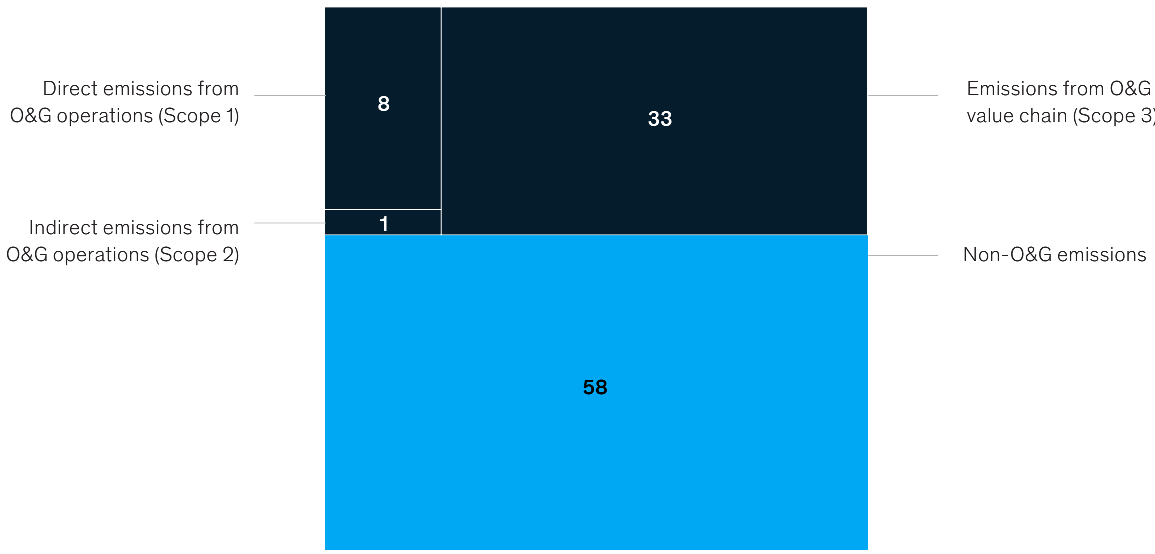
Source: World 2018 CO_2 and SF_6 emissions from fuel combustion, Organisation for Economic Co-operation and Development (OECD) and IEA; world 2018 emissions of CO_2, CH_4, N_2O, hydrofluorocarbons, and perfluorinated compounds, OECD and IEA; Global Greenhouse Gases Emissions EDGAR v4.3.2, European Commission Joint Research Centre, July 2017, edgar.jrc.ec.europa.eu; *World energy outlook 2018*, IEA, November 2018, iea.org

[1] See, for example, the Task Force on Climate-related Financial Disclosures (fsb-tcfd.org) and the CDP (cdp.net).
[2] "Investors make unprecedented commitment to net zero emissions," United Nations Environment Programme, September 23, 2019, unenvironment.org.

Exhibit 2

Directly and indirectly, the oil and gas industry accounts for 42 percent of global emissions.

Oil and gas (O&G) share of global emissions, 2015, %



Source: World 2018 CO_2 and SF_6 emissions from fuel combustion, Organisation for Economic Co-operation and Development (OECD) and IEA; world 2018 emissions of CO_2, CH_4, N_2O, hydrofluorocarbons, and perfluorinated compounds, OECD and IEA; Global Greenhouse Gases Emissions EDGAR v4.3.2, European Commission Joint Research Centre, July 2017, edgar.jrc.ec.europa.eu; *World energy outlook 2018*, IEA, November 2018, iea.org

At the same time, renewable technologies have been getting cheaper. In the United States, the cost of solar—both photovoltaics (PV) and utility scale—has fallen more than 70 percent since 2011, and the cost of wind by almost two-thirds. By 2025, they could be competitive with natural gas–based power generation in many more regions.

Other forces are also coming into play. Although there is still no global market, carbon taxes or trading systems cover 20 percent of worldwide emissions, compared with 15 percent in 2017, according to the World Bank.[3] Many European governments plan to implement binding GHG emissions targets and are drawing up national energy and climate plans.

Options for the oil and gas sector

To play its part in mitigating climate change to the degree required, the oil and gas sector must reduce its emissions by at least 3.4 gigatons of carbon-dioxide equivalent ($GtCO_2e$) a year by 2050, compared with “business as usual” (currently planned policies or technologies)—a 90 percent reduction in current emissions. Reaching this target would clearly be easier if the use of oil and gas declined. But even if demand doesn’t fall much, the sector can abate the majority of its emissions, at an average cost of less than $50 per ton of carbon-dioxide equivalent (tCO_2e), by prioritizing the most cost-effective interventions. Process changes and minor adjustments that help companies reduce their energy consumption will promote the least expensive abatement options.

The specific initiatives a company chooses to reduce its emissions will depend on factors such as its geography, asset mix (offshore versus onshore, gas versus oil, upstream versus downstream), and local policies and practices (regulations, carbon pricing, the availability of renewables, and the central grid’s reliability and proximity). Already, many companies have adopted techniques that can substantially

[3] “State and trends of carbon pricing 2018,” World Bank Group, May 2018, worldbank.org.

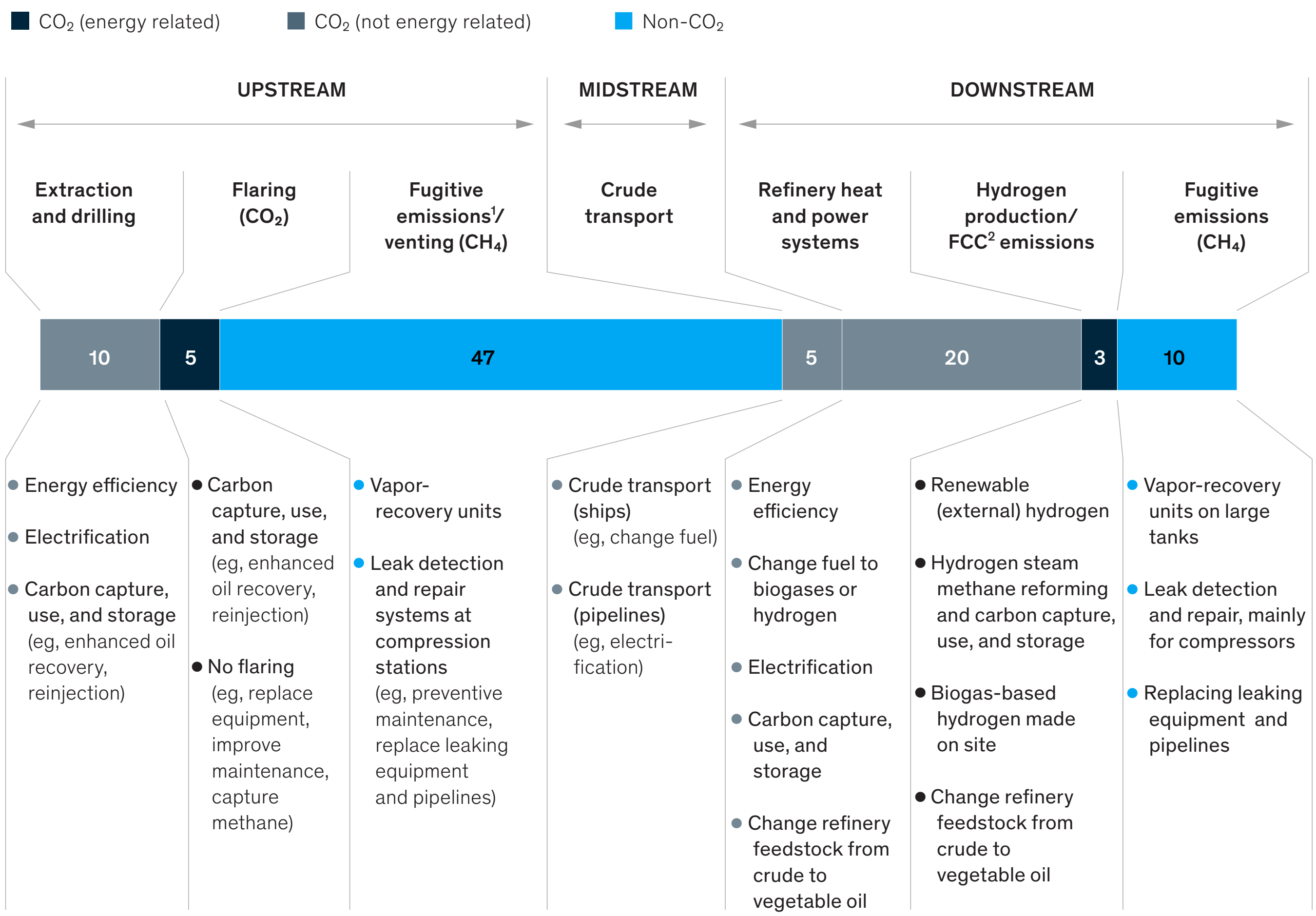
decarbonize operations—for example, improved maintenance routines to reduce intermittent flaring and vapor-recovery units to reduce methane leaks (Exhibit 3). Cutting emissions is not necessarily expensive. An onshore operator found that about 40 percent of the initiatives it identified had a positive net present value (NPV) at current prices and an additional 30 percent if it imposed an internal carbon price of $40/tCO2e on its operations.

One option is to implement initiatives that offset emissions by tapping into natural carbon sinks, including oceans, plants, forests, and soil; these remove GHGs from the atmosphere and reduce their concentration in the air. Plants and trees sequester around 2.4 billion tons of CO_2 a year.[4] The Italian energy giant ENI has announced programs to plant 20 million acres (four times the size of Wales) of forest in Africa to serve as a carbon sink.

Exhibit 3

Current technologies can address most of the oil and gas industry's emissions.

Emissions by source, share, and possible solutions, %



[1] Fugitive emissions from midstream are included in upstream (~20% of total oil and gas emissions, mainly methane) to be consistent with IEA *World energy outlook 2018* classification.
[2] Fluid catalytic converter.

Source: World 2018 CO_2 and SF_6 emissions from fuel combustion, Organisation for Economic Co-operation and Development (OECD) and IEA; world 2018 emissions of CO_2, CH_4, N_2O, hydrofluorocarbons, and perfluorinated compounds, OECD and IEA; Global Greenhouse Gases Emissions EDGAR v4.3.2, European Commission Joint Research Centre, July 2017, edgar.jrc.ec.europa.eu; *World energy outlook 2018*, IEA, November 2018, iea.org

[4] Gabriel Popkin, "Weighing the world's trees," *Nature*, June 30, 2015, nature.com.

Other companies are looking at how to fund these offset programs; Shell offers Dutch consumers the possibility of paying to offset emissions from retail fuel. The cost of carbon sinks is uncertain; estimates range from \$6 to \$120 per tCO_2e in 2030, depending on the source and the sequestration target.

Any company can invest in offsets. On the whole, however, upstream and downstream operators have different sets of options at their disposal.

What upstream operators can do

Upstream operations account for two-thirds of sector-specific emissions. Below, we discuss some ways in which oil and gas companies are taking action. The economics will vary greatly, depending on the option and local conditions.

Changing power sources. One oil and gas company is using on-site renewable-power generation to provide a cost-effective alternative to diesel fuel. By replacing generators with a solar PV and battery setup, the company not only reduced emissions significantly but also broke even on its investment in five years. Connecting onshore or nearshore rigs and platforms to the central grid (as opposed to decentralized diesel generation) can also work well: for example, in its drive for electrification, Equinor recently connected its Johan Sverdrup field, which lies 140 kilometers offshore, to the grid. If upstream producers electrified most of their operations, that could add up to 720 tCO_2e a year in abatement by 2050, at an estimated cost of \$10/tCO_2e, depending on local electricity costs.

Reducing fugitive emissions. Companies can cut emissions of methane, a powerful GHG, by improving leak detection and repair (LDAR), installing vapor-recovery units (VRU), or applying the best available technology (such as double mechanical seals on pumps, dry gas seals on compressors, and carbon packing ring sets on valve stems).[5] One company replaced the seals in pressure-safety valves, which had been found to be a frequent source of leaks, and then was able to monetize these streams of saved or captured gas.

We estimate that reducing fugitive emissions and flaring could contribute 1.5 $GtCO_2e$ in annual abatement by 2050, at a cost of less than \$15/tCO_2e.

Electrifying equipment. One company replaced gas boilers with electric steam-production systems, including high-pressure storage for nighttime steam supply, to support separation units. The project will pay for itself in less than ten years. In many circumstances, there is already a good business case, on purely financial grounds, for combining the use of solar and gas in place of conventional boilers.

Reducing nonroutine flaring through improved reliability. One operator found that 70 percent of all flaring emissions came from nonroutine flaring, mainly as a result of poor reliability. It therefore focused on improving its operations—for example, by carrying out predictive maintenance and replacing equipment. These actions not only reduced emissions but also raised production. Best-in-class operators are making significant strides in reliability thanks to area-based maintenance and multiskilling. Predictive analytics can reduce the frequency of outages to compressors or other equipment.

Reducing routine flaring through improved additional gas processing and infrastructure. While some flaring may be unavoidable, the capacity constraints of infrastructure can lead to more than either companies or the public might want. In the Permian Basin, for example, a record 661 million cubic feet a day (mcf/d) were flared in the first quarter of 2019. Addressing this challenge requires additional gas-processing facilities, as well as gathering and transport infrastructure. The Gulf Coast Express natural-gas pipeline, which went operational in September, will help. An additional 16 billion cubic feet a day (bcf/d) of planned capacity increases on pipelines from the Permian to the Gulf Coast is now under discussion.

Increasing carbon capture, use, and storage (CCUS). While this technology is projected to play only a minor role in the sector's overall decarbonization, O&G players can still significantly influence its

[5] *World Energy Outlook 2018*, International Energy Agency, November 2018, iea.org.

adoption and development. There are 19 large-scale CCUS facilities in commercial operation; four more are under construction and another 28 in development. There are also a number of demonstration and pilot projects. Together, plants under construction and in operation can capture and store about 40 $MtCO_2e$ a year. Total CCUS capacity could increase by as much as 200 times by 2050. In this market, the oil industry is well placed to lead because it already uses carbon captured via CCUS for use in enhanced oil recovery (EOR). That oil is also less emissions intensive than the conventionally extracted variety.

A number of countries are looking to accelerate CCUS development. In 2018, for example, the US Congress passed a provision (45Q) increasing the tax credit that power plants and industries can take for either storing or using captured carbon. Congress is considering a bill, known as USE IT, to support the construction of CCUS facilities and CO_2 pipelines and to finance research on direct-air capture. The business case for CCUS works only under specific economic conditions, such as tax relief or the imposition of a carbon price. Without some kind of regulatory framework, CCUS does not create value in and of itself.

CCUS costs \$20/tCO_2e for selected processes in the oil and gas sector but as much as \$100 to \$200/tCO_2e in other industries, such as cement. One undertaking to watch is the Clean Gas Project in northern England, where a consortium of six oil and gas companies is building what could be the first commercial natural-gas plant with full CCUS capacity.

Rebalancing portfolios. Operators are starting to take a close look at their upstream portfolio choices. The highest-emitting reservoirs are nearly three times more emissions intensive than the lowest. For example, complex reservoirs—highly viscous, in deep or ultradeep water, compartmentalized, or high pressure and temperature—may be at a structural emissions disadvantage. They may therefore become increasingly unattractive to develop in the future.

What downstream operators can do

Downstream operators are exploring many of the same ideas, such as energy efficiency and the electrification of low- to medium-temperature heat and energy. But they have distinctive options as well.

Energy efficiency. Efficiency is a factor in every part of the industry, of course, but new downstream-specific technologies can make a big difference. Waste-heat-recovery technology and medium-temperature heat pumps in refineries, for example, reduce the amount of primary energy used in distillation. One company saved €15 million in capital expenditures by forecasting its required steam usage hour by hour and incorporating this into a thermodynamic model to determine the required specifications for replacement equipment.

Green hydrogen. Hydrogen production through electrolysis has become both more technically advanced and less expensive. Bloomberg New Energy Finance estimates that the cost of hydrogen could drop as much as two-thirds by 2050. Using renewable energy rather than steam methane reforming (SMR) to power the electrolysis could offer refineries a way to reduce emissions—a result known as “green hydrogen.” An alternative, “blue hydrogen,” uses SMR plus CCUS. The attractiveness of the different technologies depends on the local economics—in particular, the availability of cheap storage capacity for CCUS or cheap renewable electricity.

Green hydrogen is not a speculative technology in oil and gas. Shell and ITM Power, a UK-based energy-storage and clean-fuel company, are building the world’s largest hydrogen electrolysis plant at a German refinery, with support from the European Union. Revenue will come from selling hydrogen to the refinery, which will use it for processing and upgrading its products and for grid-balancing payments to the German transmission system. That business model justifies the installation.[6]

High-temperature electric cracking. In refining, several pilot projects use electric coils (instead of fuel gas) to provide heat. The technology is still at

Planning a decarbonization strategy: Questions to ask

Companies are at different stages of preparing their GHG-reduction plans: some are ready to act, others are just getting started. Here are questions companies should ask as they plan and execute strategies to reduce GHG emissions.

Goals. What is the baseline for setting targets? What are the targets over the next three to five and five to ten years, as well as to 2050?

Initiatives. What is the most cost-effective way to decarbonize our different sources of emissions? What is the business case for each asset? How can our company manage the trade-offs between longer-term decarbonization and shorter-term growth, revenue, and sustainability targets?

Management. What capabilities do we need centrally or in business units? What is the right organizational setup? How do we allocate capital for decarbonization across the portfolio? How do we measure and track success?

Stakeholder strategies. How can we get investors, employees, customers, and governments to support our decarbonization agenda? What is the investment case? Are new sources of funds available? How can we differentiate our products? When should we collaborate or go it alone?

Energy transition. How do we align our decarbonization goals with the larger energy transition? What is the right timeline and payback period?

an early stage and small in scale. Moreover, the economics are sensitive to the price of electricity compared with gas and to the options for selling the fuel gas. Those economics improve if investment is coordinated with the natural investment cycle to support additional capital expenditures—and, of course, if power can be purchased or generated under favorable financial terms.

Greener feedstocks. Replacing some conventional-oil feedstocks in refineries with biobased feedstocks or recycled-plastic materials (initially, through pyrolysis or gasification) would also reduce emissions—not only Scope 1 but also, to a large extent, Scope 3 emissions. In an increasingly decarbonizing world, this may extend the lifetime of refining assets.

The oil and gas sector will play an important role in the global energy transition; how it will face that future is a matter of strategy. As transparency increases, so may expectations. Customers, employees, and investors are already starting to distinguish the leaders from the laggards. Oil and gas companies that get ahead of the curve could find themselves better positioned for change.

[6] "World's largest hydrogen electrolysis in Shell's Rhineland refinery," ITM Power, January 18, 2019, itm-power.com.

This article is part of a series on energy transition and decarbonization.

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