EXECUTIVE INSIGHTS

Methane Emissions in the Oil Field: Issues and Opportunities

Methane emissions waste a valuable commodity. They're also a key contributor to global warming, accounting for roughly 16% of greenhouse gases (GHGs).[1] These two factors have led to a consensus among industry leaders and environmentalists that it makes sense to curb leakages of methane gas.

Sources of methane emissions are heavily concentrated in the oil and gas sector, which is navigating a broader transition to cleaner, lower-carbon energy. As more oil and gas companies commit to net-zero targets, controlling methane emissions may be the fastest way to make good on the pledge to improve their carbon footprint. This has prompted changes in upstream processes and investment in new technologies.

To size up the potential of the emerging methane management market, industry executives and investors need to ask these four questions:

1. How big of a problem are methane emissions in oil and gas?
2. How do companies address methane emissions today?
3. What are the key challenges to reducing methane emissions?
4. Where are opportunities to invest in the market?

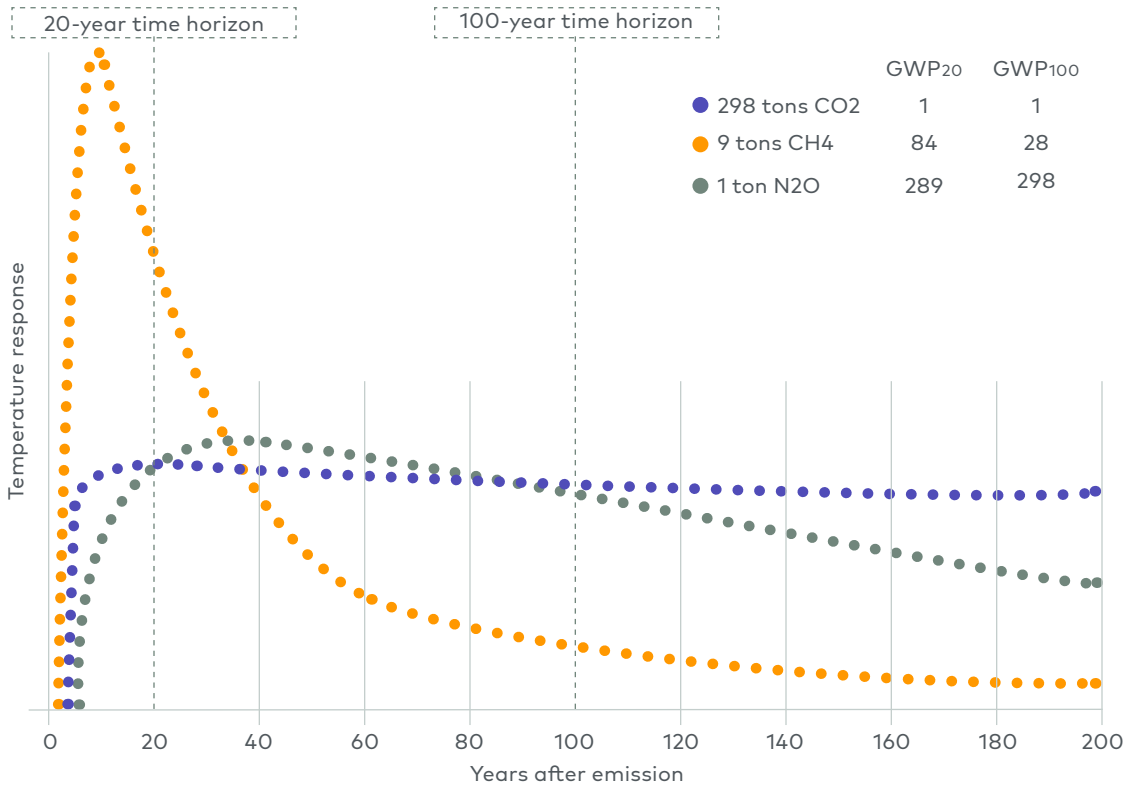
Here's what we know so far.

1. How big of a problem are methane emissions in oil and gas?

Most of the conversation around climate change and the environmental impact of emissions has been about carbon dioxide and carbon footprint. Carbon dioxide does account for most of the GHG emissions from human activity.[2] Unlike other reactive gases, it also stays in the atmosphere for hundreds of years.[3]

So why are methane emissions so relevant? One way to evaluate the relative effect of a GHG is by looking at its global warming potential (GWP), which measures how much energy one ton of the gas will absorb over time versus one ton of carbon dioxide (see Figure 1). The U.S. Environmental Protection Agency estimates that methane has a 100-year GWP of 28-36.[4] In other words, it's at least 28 times more potent than carbon dioxide over the course of a century. In the shorter term, measured over 20 years, methane's GWP soars to 84 times that of carbon dioxide.[5]

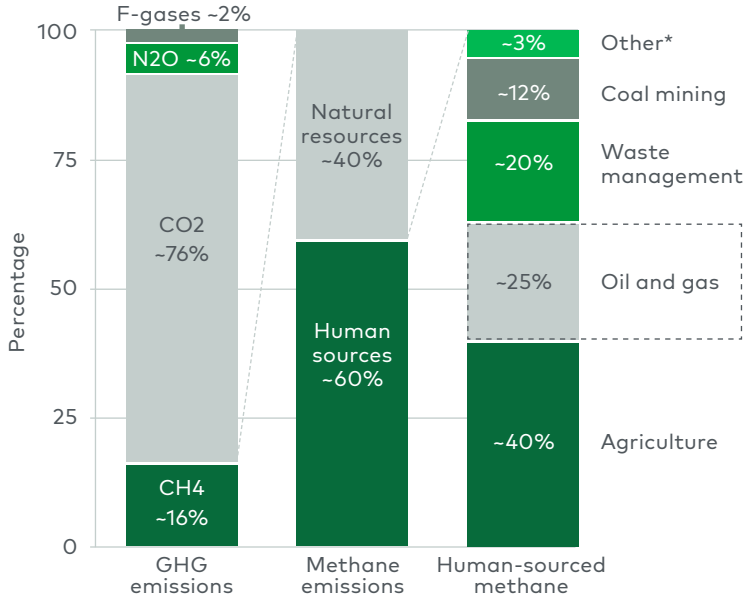
Figure 1
Global temperature effects of one-off carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) emissions in year zero



Source: U.N. Intergovernmental Panel on Climate Change (IPCC); U.S. Environmental Protection Agency (EPA); U.N. Environment Program Global Methane Assessment (2021); Planetary Vegan

This brings us to the question of where methane emissions are coming from. About 40% are from natural sources like digestion residuals and the decay of organic material. The rest is from human activity, and 25% of that activity is in the oil and gas industry (see Figure 2).

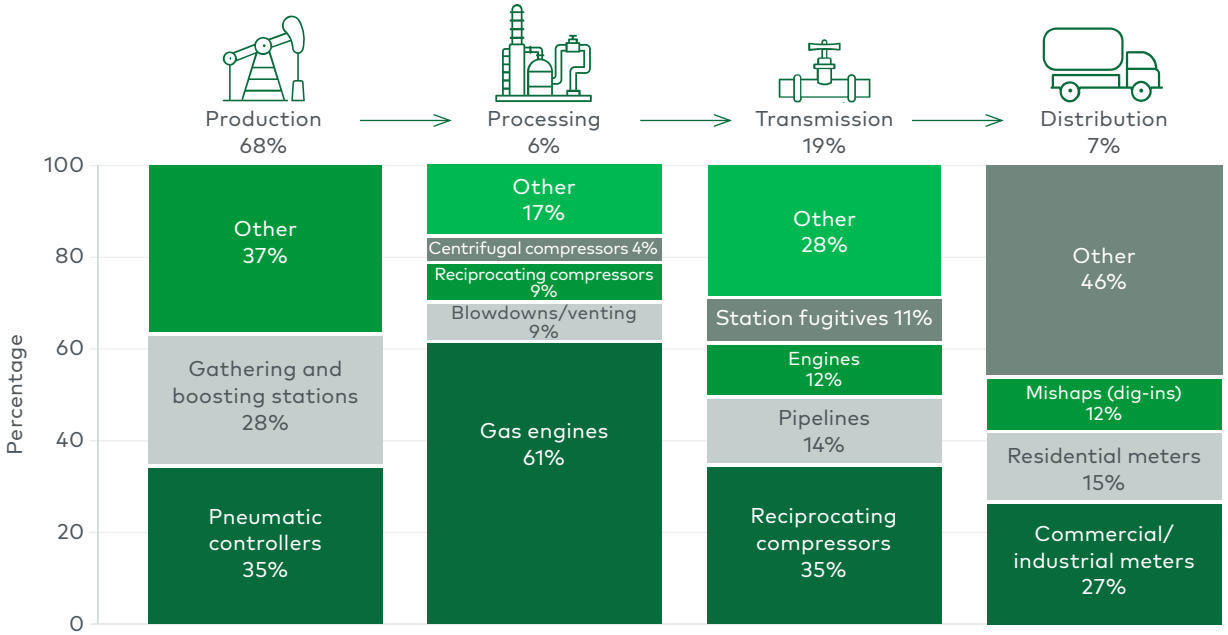
Figure 2
Global GHG emissions (2021)



*Other gases include hydrofluorocarbon-23, carbon tetrafluoride, sulfur hexafluoride and other fluorinated gases, making up 2% of global GHG emissions
Source: IPCC; Climate Change Connection; EPA; Council on Foreign Relations: Environmental Defense Fund; U.N. Environment Program Global Methane Assessment (2021)

Globally, three-quarters of oil and gas methane emissions come from upstream activities,[6] specifically gas production and associated gas linked to oil production. Midstream and downstream activities, mainly those related to gas transmission and distribution, account for the remainder (see Figure 3).

Figure 3
Emissions across the oil and gas value chain



Note: Estimated breakdown by equipment type varies across fields, basins and regions; the above values represent total segmentation for the U.S. oil and gas lower-48-state region and include onshore and offshore operations
Source: EPA; L.E.K. research and analysis

2. How do companies address methane emissions today?

These realities have put oil and gas methane emissions under growing scrutiny. Exploration and production (E&P) companies are responding with a set of strategic initiatives aimed at reducing the environmental impact of field operations. One of those initiatives is to expand methane reduction goals beyond the emissions that the company makes directly (also known as Scope 1 emissions).[7] Now, supermajor E&P companies are also setting well-defined targets for reducing indirect Scope 2 and 3 emissions in the next five to 10 years.

In addition, most of the supermajors have set net-zero targets for 2050 or earlier. The common trend among this group is to tie their net-zero pledge with initiatives that let them deal with methane emissions that fit each individual operational environment. BP[8] and Shell,[9] for instance, aim to increase the proportion of green energy sources they use relative to high-carbon-footprint oil and gas, while others, like ExxonMobil,[10] TotalEnergies and Chevron, are pledging a more aggressive expansion of their leak detection and repair (LDAR) programs in the field.

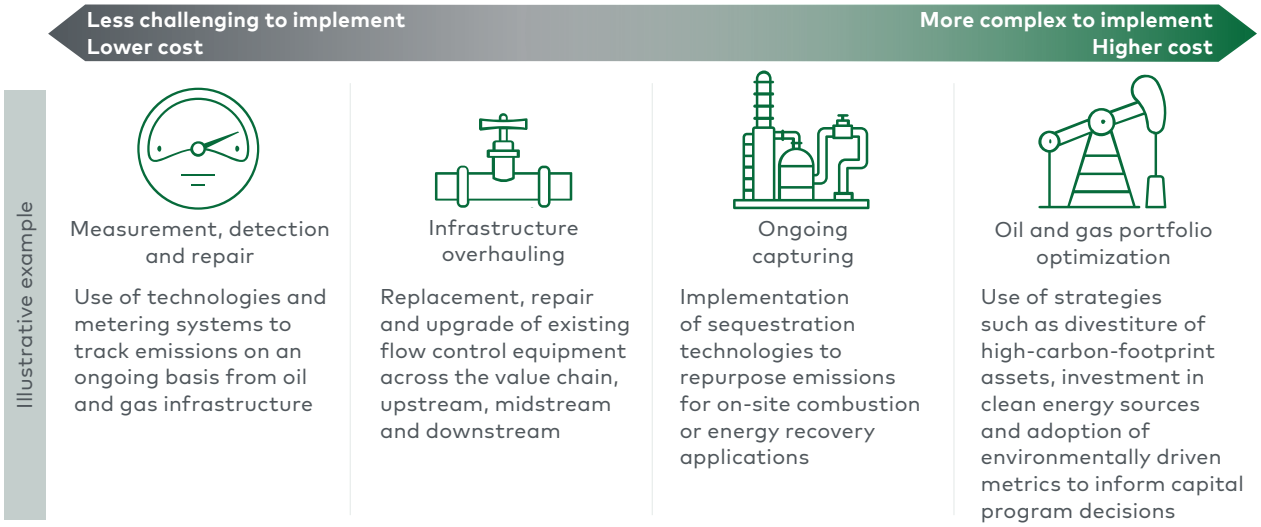
At the next tier of E&P players, strategies are more of a mixed bag. Companies like EQT, Occidental Petroleum and Marathon Oil have set clearly defined Scope 1, 2 and 3 emission goals for the short term. Others like EOG Resources, Ovintiv and Pioneer Natural Resources are focusing on Scope 1 and 2 for the time being. Then there are smaller players that are just starting to define strategies around Scope 1 emissions — Southwestern Energy, Continental Resources and Oasis Petroleum among them.

This is a fluid situation, and specific strategies are likely to change. For the time being, though, companies are relying on a variety of ways to account for and address methane emission targets, and to achieve the reduction targets they set (see Figure 4). Notable ones include:

Measurement, detection and repair solutions. Most of the supermajors have adopted LDAR programs, mainly to address fugitive emissions. Examples: TotalEnergies has added offshore measurements to its portfolio of satellite, airborne and analytical capabilities. At Occidental Petroleum, infrared optical gas imaging cameras and on-site audio, visual and olfactory sensors are used to inspect equipment and gather and analyze emissions data.

Infrastructure overhauling. Old oil and gas infrastructure — everything from valves to compressors to pneumatic injection pumps — tends to leak, making it a significant source of methane emissions. About 10% of leaks can be avoided at marginal cost, and the benefit in any case would offset the replacement cost over the long term. Another 40%-50% could be addressed by replacing or upgrading critical equipment during regular maintenance over the next three to five years.

Figure 4
Current approaches to managing emissions



Source: Company investor's presentations and public announcements

The rest has more relevant cost and operational implications for operators. Examples: Marathon has launched a program to replace old components across the oil and gas value chain. Cimarron has designed tankless facilities[11] that eliminate the need for temporary storage. And in 2015, Anadarko opened a facility that pipes crude oil directly from the wellhead to the stabilization facility,[12] keeping methane out of the atmosphere.

On-site capturing and repurposing. Carbon capture, utilization and storage, which has been more focused on carbon capturing technologies, is rapidly expanding into methane emissions, too. These methane capturing technologies include using vapor recovery units and vapor composition units. Example: ConocoPhillips undertook a rigorous program to install vapor recovery units at all central facilities so it could capture low-pressure emissions from oil and gas tanks.

Portfolio optimization. In a bid to manage emissions, companies are divesting assets and inserting new, environmentally driven metrics to support capital program decisions. Examples: BP and Shell are among those that have shed oil and natural gas assets. Meanwhile, Repsol, Eni and Equinor are accounting for GHG intensity metrics (including methane) in their asset portfolio prioritization programs.

3. What are the key challenges to reducing methane emissions?

There are no standards for measuring or reporting on emissions today. Even what to measure and report can vary. Direct or indirect emissions? Full operations or active infrastructure only?

Entire value chain or upstream only? It's all up in the air — no pun intended — and exacerbates the lack of consistency across the industry.

Some companies take a top-down approach to measurement and use satellites or other surveillance to detect and estimate emissions. Other companies work from the bottom up, tracking key assets and their production and estimating expected emissions from operations.

Top-down measurement ties the accuracy of readings to the concentration of gases. That makes these approaches highly effective for high-emission incidents. But atmospheric conditions sometimes interfere with data readings, potentially limiting the satellite technology to onshore operations.

In addition, although top-down approaches are more comprehensive, they tend to overestimate emissions because it can be hard to allocate volumes to specific companies or equipment. That's especially true for areas with complex multi-industrial activity. But even top-down analytics providers that single out oil and gas operations more accurately, such as Paris-based Kayrros or San Francisco-based Geofinancial Analytics, can still struggle to narrow emissions down to specific companies.

Bottom-up measurement spans a variety of specific technologies that different companies have implemented in the field to track emissions. For instance, Boston-based M.J. Bradley & Associates compiles upstream data and estimates GHG emissions for carbon dioxide, methane and nitrous oxide for onshore oil and gas companies.

The nonstandardized metrics used in these approaches make comparisons difficult. It might help if more companies adhered to the U.S. Environmental Protection Agency's (EPA) voluntary methane programs, but EPA guidelines consider only specific equipment in any case. The rest of the emissions are calculated based on rough averages and prorate total basin aggregates by ownership attribution. The results often underestimate emissions because of gaps in the data, especially around upstream operations. Commonly omitted data points include abandoned oil and gas wells, unused facilities, and infrastructure not easily tracked to production. In addition, different calculation methods can produce different results.

Reporting is just as inconsistent. Apart from the issues with data sources and quality, no standard reporting system exists either globally or regionally. That leaves E&P operators with considerable discretion in what to include in their emissions and sustainability reports.

E&P companies generally adopt protocols based on their individual affiliation and nature of operations. The most common is the Greenhouse Gas Protocol, which encourages but doesn't

require Scope 3 reporting. Other protocols include those from the World Resources Institute,[13] Oil & Gas Climate Initiative[14] and Ipieca.[15] All rely on self-reporting rigor.

Some official systems have well-defined reporting mechanisms and frequencies, but they still allow for flexibility in what data to report and infrastructure to cover. For example, the EPA's Greenhouse Gas Reporting Program requires companies to report their emissions but offers only a guideline on what assets and scope to include.[16] Even so, it's the closest the U.S. is to reporting standardization.

Mind the reporting gap

The issues around methane emissions reporting are visible at national, local and industry levels. For example:

- Scientists note a gap of 5.5 billion tons[17] between GHG emissions acknowledged by countries and the emissions calculated by independent models
- There is an 18% discrepancy[18] between what cities report and the emissions calculated by independent models
- Environmental Defense Fund research reveals that methane emissions are 60% higher[19] than data reported to the EPA

Business considerations can also get in the way of effective ongoing methane emissions reduction initiatives. For one thing, there's the cost of the analytics and monitoring solutions required to monitor methane emissions. Their economics can be hard to justify when other projects offer higher capital returns.

In addition, oil and gas players must engage specialized staff to carry out emissions initiatives — no small proposition in a tight labor market. Limited expertise in the field has prevented faster adoption of emission reduction initiatives and led to greater reliance on third-party suppliers.

Shareholders are another challenge. They're more focused on reducing GHG emissions than ever before, but some are expressing this intent by diverting capital from oil and gas companies. Others may resist management incentives for boosting the budget for renewable solutions in the company's annual investment program.

Regulations are still another challenge, given their complexity. The political climate is promoting initiatives to increase accountability for corporate GHG emissions. In November 2021, at the United Nations Climate Change Conference, over 100 countries committed to a 30%

reduction in methane emissions by 2030.[20] In the U.S., Congress has proposed legislation that would impose fees on methane. These include a bill introduced in the Senate to impose a fee of $1,800 per ton for excess methane emissions beginning in 2023, and a similar measure in the House of Representatives proposing a fee of $1,500 per ton.

The Biden administration is pursuing a number of related initiatives in the meantime. By the end of 2022, the EPA aims to finalize the Clean Air Act, which is geared toward reducing methane emissions through both new and modified oil and gas facilities while imposing emissions requirements for existing facilities. The Department of Transportation is increasing pipeline safety protocols, bringing an additional 425,000 miles of pipeline under its regulatory umbrella and mandating safety reporting requirements. And the Department of Agriculture has created farm programs to reduce methane emissions and collect methane emissions for use in renewable energy.

Public policy is likely to continue in this direction even if the political environment changes, prompting E&P companies to implement effective GHG emissions programs.

4. Where are opportunities to invest in the market?

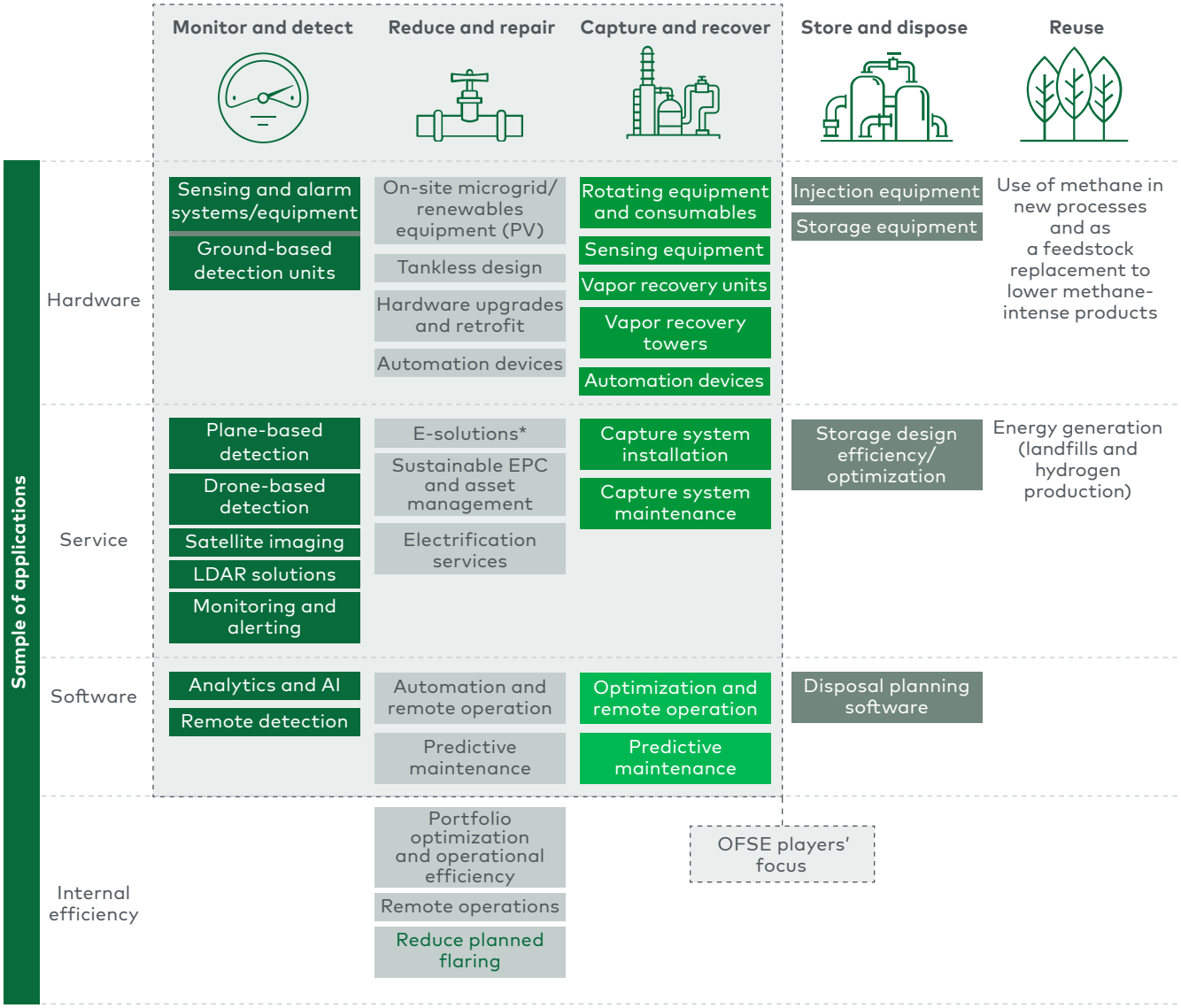
Amid these challenges, investors have a range of opportunities across the technology landscape. Applications include hardware, services and software solutions, along with internal efforts at E&P companies to improve their efficacy to monitor and reduce emissions (see Figure 5).

Oil-field service and equipment (OFSE) companies (as well as new, specialized non-oil and gas technology providers) mainly play in the first three steps of this landscape:

Monitor. Besides LDAR programs, emissions analytics and artificial intelligence, emissions monitoring and measurement solutions are continuing to gain acceptance among E&P operators. Aerial technologies include airplanes and drones by companies like Kairos Aerospace, Bridger Photonics and SeekOps. Satellite providers include GHGSat and MethaneSAT. And for remote solutions, Qube Technologies, Urbint and Scientific Aviation are among the companies to watch.

Reduce. When it's time to replace or upgrade critical hardware, oil and gas companies turn to traditional OFSE manufacturers like Baker Hughes and Schlumberger. But technologies to reduce fugitive emissions are different. Emerging trends in this part of the methane management landscape include technologies focused on automation, electrification and renewable solutions. There are also innovative processing configurations such as tankless design from Cimarron and DXP-IFS, among others.

Figure 5
Methane management framework



Note: LDAR=leak detection and repair, AI=artificial intelligence, PV=photovoltaic and EPC=engineering, procurement and construction
*Includes e-Frac and e-Rigs
Source: IEA; Atlantic Council; L.E.K. research and analysis

Capture. For emissions capturing, look to wellsite and processing facility solutions. These include vapor recovery units from companies like Flogistix, Air Mac and Cimarron's HY-BON division. Also in this category: vapor recovery towers from Waterford Tank and Fabrication, OTA Compressors, and others.

Other aspects of the value chain are still in the early stages. They're typically dominated by in-house solutions from E&P companies, such as Anadarko's Central Oil Stabilization Facility concept.

Shaping up a strategy

As is so often the case, one good question leads to another. Sorting out the status of oil and gas methane management raises further considerations for investors as they assess the market's outlook.

First is industry outlook. That includes how quickly E&P companies will implement methane management initiatives in their respective operations and who will lead in each specific region or basin. There are also considerations around methane management technologies, including how they will improve and evolve over time. Evaluate the growth potential for each technology across the value chain in light of emerging preferences, key adoption criteria and challenges. Also take care to understand the extent that policy drives the adoption of each technology, and how policy support (or other tailwinds like structural changes in the economy) counteract headwinds. Finally, try to get an idea of which countries or regions will promote adoption of GHG emissions technology sooner.

On top of those considerations are key questions about strategic fit. See whether the investment theme in emissions offers the right exposure to the energy transition or environmental, social and governance (ESG) principles. Does it strike the right balance between opportunity and risk? For investors, this means being able to appropriately represent the business as an ESG solution versus an oil and gas equipment or service company. Also determine whether the selected emissions theme and the business models found in it align with the company's current portfolio and investment profile. From a technology perspective, consider how far the selected technology is in the life cycle and how it fits the company's investment horizon. Then there's the question of whether actionable acquisition targets in the market are within the appropriate range of investment.

When it comes to methane emissions, public and private interests are exceptionally aligned, giving oil and gas companies a green light to pursue methane management solutions. By asking the key fundamental questions about the direction of this still-evolving market, industry executives and investors can determine which approaches and solutions support the achievement of net-zero targets while yielding benefits to stakeholders inside and outside the organization.

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