Apprehending Fugitive Emissions: Applying Innovative Technologies to Capture Escaping Methane Gas

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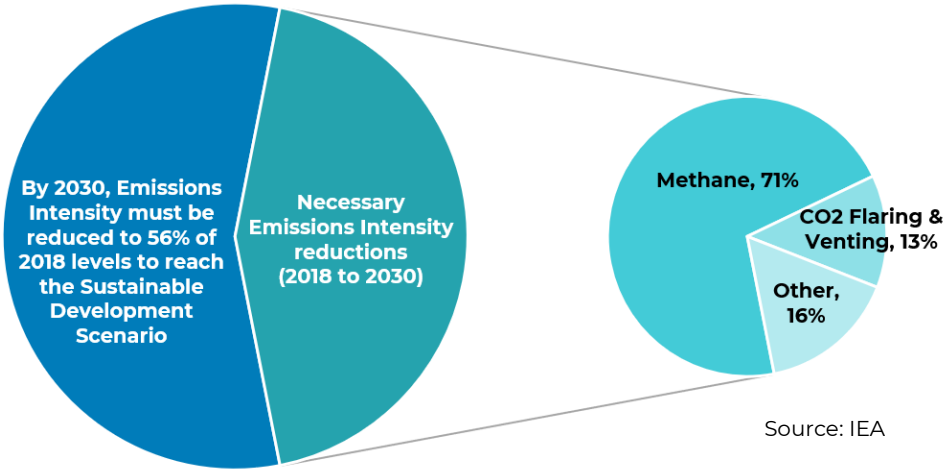
While investment community discussions about reducing greenhouse gas emissions worldwide have spotlighted carbon dioxide, the greenhouse gas doing most near-term damage is methane. The primary component of natural gas, methane is more difficult to detect and measure than other greenhouse gases and it inflicts up to 84 times more environmental harm versus carbon dioxide.[i]

"Fugitive methane emissions," meaning those that escape undetected and unplanned, result from leaks that have historically been difficult to find or isolate. Because of methane's high potency, significantly reducing fugitive methane emissions would contribute progress toward broader greenhouse gas (GHG) reduction goals. **Several innovative technologies have been developed that are already helping to solve this fugitive emissions problem.** In many cases, oil and gas companies are incubating solutions within their internal investment arms for widescale adoption. In other instances, independent entrepreneurs are tackling fugitive emissions and creating investable opportunities for institutional investors seeking ESG solutions that also offer attractive return potential.

Methane's outsized impact

Pound for pound — or in metric terms, tonne for tonne — methane is a more potent global warming compound than carbon dioxide (CO_2), despite the fact that methane remains in the atmosphere for a fraction of the time that carbon dioxide does. Why is that? Methane molecules can absorb greater amounts of the earth's radiated heat energy versus an equivalent weight of CO_2. In fact, over a 20-year period, methane is 84 times more effective in absorbing this energy in the atmosphere than is carbon dioxide. A resulting gradual rise in global temperature occurs over time as excess GHG's accumulate in the atmosphere.

Scientists created a common scale, called GWP or Global Warming Potential, to compare energy absorption and retention capacities of different greenhouse gas components. Since carbon dioxide is the predominant global warming pollutant, it forms the basis of the GWP scale. All other GHG's can be expressed as "CO_2 equivalents", or CO_2e. Hence, a ton of methane has 84 times more global warming potential, or GWP, than a ton of carbon dioxide over a 20-year period, despite its shorter life.[ii]



Source: IEA

Low-carbon Sustainable Development Scenario model: Required change in oil & gas emissions intensity from 2018–2030 to meet Paris Agreement goals

Given methane's outsized impact, acting now to reduce the amount of this particular gas being released into the atmosphere is critically important. Some analyses have shown that taking action now on the "little things" that can reduce methane emissions — meaning incremental efficiencies and process improvements in the energy supply chain — could have the same equivalent carbon reduction effect as shutting down 60% of the world's coal-fired plants and replacing them with zero emissions energy generation.[iii] According to the IEA, 70% of methane emitted by the energy industry can be eliminated without delay by applying technology available today, more closely monitoring for leaks, and making timely repairs.[iv] Installing technologies that prevent wasting of methane gas through venting, flaring, and fugitive emissions are among the easiest and most cost-effective ways to reach the goals of the Paris Agreement.

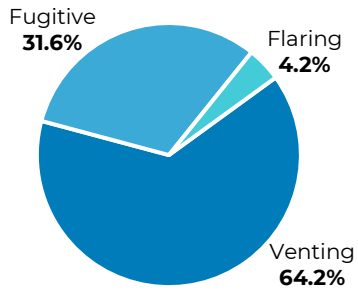
A range of commercially viable solutions will encourage action on fugitive emissions. Up to half of avoidable methane emissions can be abated for no net cost because, unlike CO_2, methane has substantial monetary value.[v] The more we capture and avoid wasting, the more can be sold or used as a replacement fuel.

Innovative technologies addressing this market need can move us to next-level operational protocols and closer to a low-GHG emissions energy supply.

Causes of fugitive emissions

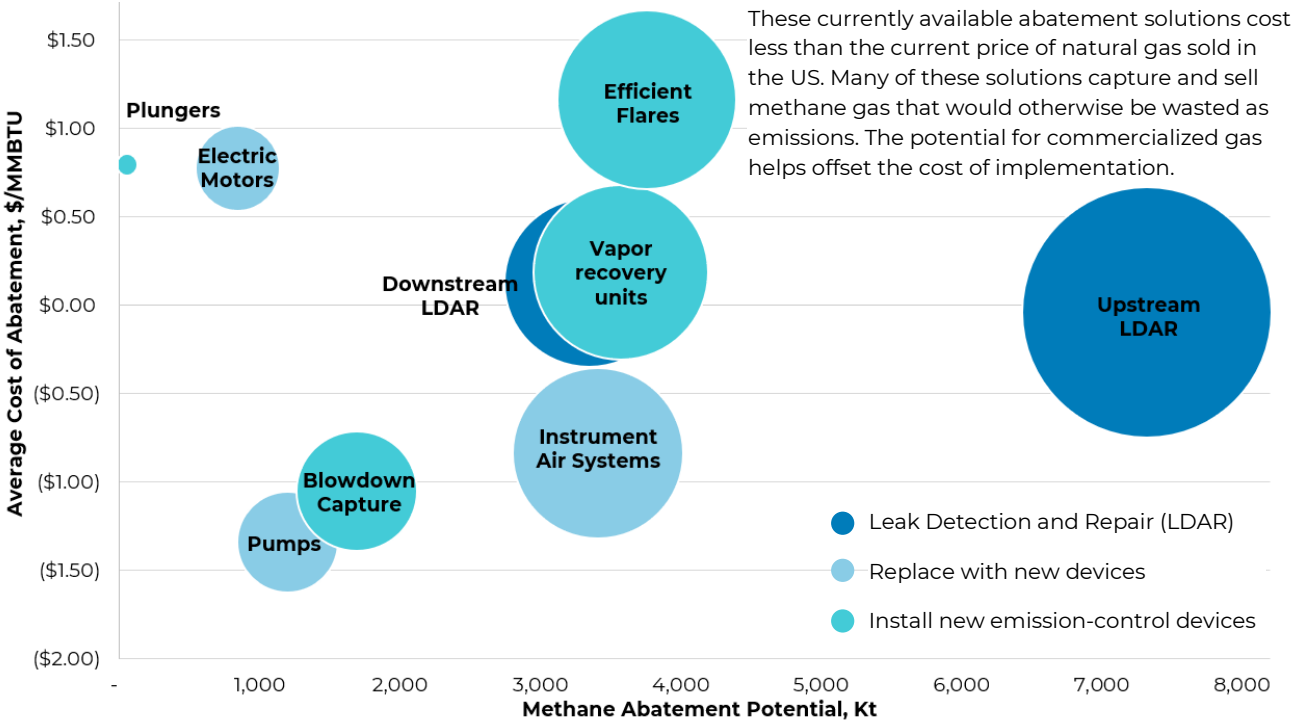
In North America, the two largest sources of methane emissions in the energy sector are venting and fugitive emissions.[vi] Vented emissions were intentionally designed into the production process for operational and safety reasons that made sense years ago. Fugitive emissions, on the other hand, are unintentional — often the result of leaky valves, compressors, or industrial hardware. While we think of oil and gas production as being focused on modern horizontal wells, nearly half of all wells actively producing today were drilled more than two decades ago[vii], meaning that

Sources of Methane Emissions



Source: IEA

Net-zero cost solutions for abatement of methane emissions (Source: IEA)

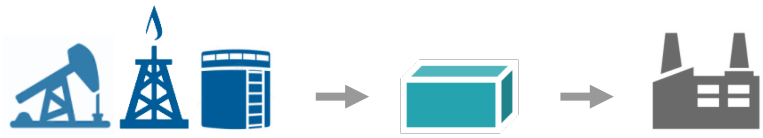


These currently available abatement solutions cost less than the current price of natural gas sold in the US. Many of these solutions capture and sell methane gas that would otherwise be wasted as emissions. The potential for commercialized gas helps offset the cost of implementation.

much of today's production is using old equipment. Despite that, many steps can be taken right now to meaningfully reduce fugitive emissions, by integrating new technologies with both old and new equipment.

GHG leaks occur throughout the complex series of processes that comprise oil and gas infrastructure systems. Leaks can occur at almost any point along the value chain — in production operations, in gas gathering and processing facilities, in refineries, and during transportation and distribution to end-use consumers. In the production and processing portion of the chain, fugitive emissions often occur at valves, various types of screwed or bolted connections, flanges, and open-ended lines and pump seals. Myriad GHG reduction opportunities exist in replacing old equipment with devices boasting new, yet relatively inexpensive, technology. In the following section, we have summarized a selection of technologies available now that can meaningfully reduce fugitive methane emissions.

Emissions activities reported by the oil & gas sector



Natural gas or oil well pad
Emissions from leaks, pneumatic devices, storage tanks, unloading liquids from wells, compressors, dehydrators, and flaring.

Gathering compressor
Emissions from leaks, pneumatic devices, and compressors.

Gas processing plant
Emissions mainly from compressor venting and leaks.

Source: EPA.gov

Tactical opportunities to reduce methane emissions

Pneumatic controllers

Pneumatic controllers run on natural gas and are responsible for controlling fluid flow in common production equipment. They use the pressure of the gas within small tubes to open and close valves. In the course of normal use, hundreds of thousands of these devices continuously release, or "bleed," methane as valves move. This is an old technology that has not previously had the impetus to change, however, newer "zero-bleed" devices do not vent natural gas at all. Some zero-bleed controllers run on compressed air instead of natural gas, while others are powered by electricity from the grid or from a solar unit. The switch to no-bleed or low-bleed alternatives is often economically beneficial, and the fact that the non-leaked methane gas can be sold renders this equipment update a responsible and viable solution.

Flares

While many investors are familiar with flaring, most do not realize that a fully burning flare stack is less environmentally damaging than an innocuous looking unlit flare stack. When a flare is lit, methane gas is burned to intentionally convert it into a mixture of carbon dioxide, water vapor, and heat. However, an unlit flare stack allows methane gas to escape without conversion to CO_2, thereby releasing unprocessed methane with 84 times more global warming potential than CO_2. Inefficient flare stacks, where the combustion process is not thorough, are also an environmental issue because they release some portion of more-harmful methane, plus a range of volatile organic compounds and black smoke. Flare efficiency can be improved by using air-assisted or steam-assisted flares, which help create mixture conditions ideal for achieving nearly complete combustion. Digital and ultrasonic technologies are being developed to monitor flare efficiency, thus prompting adjustments to improve combustion efficiency.

Leak Detection and Repair (LDAR)

Leaks from sealing equipment or parts such as connectors and valves are a major source of fugitive methane emissions, accounting for approximately 2.4 million tons of methane per year in the US.[viii] Seals degrade from wear and tear and they can also malfunction due to human error. If connections are not tightened properly to begin with, they may leak from day one. These

Case Study: High-tech innovation for low-tech leaks

Cumulus

Cumulus Digital Solutions

The equipment used in producing, storing, and transporting oil and gas is held together by bolts, a low-tech component whose safety can be greatly enhanced by a high-tech innovation. The bolts on gas equipment such as fluid flow pipes need to be sufficiently tightened, but not over-tightened. Upholding such precise torque specifications for bolts is essential for safety, environmental protection, and operational costs across a range of industries. In the energy industry, bolted flanges must hold equipment together even in extremely high pressure and high temperature environments.

Improper assembly and maintenance of bolted connections leads to significant undetected emissions. The EPA's 2018 GHG survey reported that equipment leaks caused 7% of GHG emissions attributed to the highest emitting oil and gas industry segment, aside from production itself.[ix] A separate study found that 55% of methane emissions came from equipment leaking fugitive gases, and bolted connections comprised 30% of the leaking components.[x] Applied worldwide, this yields an estimated 170 million metric tons of fugitive GHG emissions that could be avoided each year by securing bolts the right way, the first time.[xi] That is the same amount of CO_2 emissions generated annually by 36 million passenger cars, or approximately one-fifth of all cars driven in the US each year.[xii]

Industrial IOT is playing an increasing role in reducing leaks and fugitive emissions. Cumulus, an "Internet of Tools" SaaS company, has developed innovative solutions proven to eliminate leaks for its customers. Cumulus was started within the technology incubator of Shell E&P before spinning out to address the worldwide need for proper assembly and maintenance of bolted joints. The company's Smart Torque System™ collects data from digitally enabled tools via a cloud-based platform. Managers and technicians use SmartTorque's data to ensure that bolted connections are tightened to exact torque specifications, which results in safe, secure connections that prevent leaks and drastically reduce fugitive emissions.

In addition to the significant environmental benefits, the cost savings achieved with Cumulus's innovative technology are substantial. Until the availability of precise, cloud-based monitoring, personnel would be deployed to the field to conduct in-person inspections to verify the quality of the bolted connections. Now, cloud-enabled tools such as Smart Torque System enhance speed of information and response to issues, accuracy, and accountability, without requiring humans with clipboards in the field.

Basic quality assurance practices go a long way toward preventing equipment leaks from happening in the first place. Ensuring zero leaks upfront is the first step towards reducing the risk of environmental damage and excess expense associated with rework. While costs to detect and repair leaks after they happen can add up quickly, the cost to confidently secure bolted connections to their recommended torque levels is a prudent, responsible investment.

unintentionally leaked emissions can be found by using specialized methane-detecting infrared cameras, some of which are deployed using drones. When made a routine process, this method identifies leaks early enough to fix them before much gas escapes. In so doing, the cost of the cameras and the time to conduct routine leak detection surveys is covered by the value of the retained and sold gas. In other words, enhanced monitoring and faster repairs that pay for themselves pave a logical path for integrating technology into the production chain. The case study above on Cumulus Digital Solutions highlights a specific technology that addresses exactly this cause of fugitive emissions.

Conclusion

Increasing global awareness of the importance of reducing methane emissions will drive critical process changes. As energy companies continue pledging to do their part to reduce greenhouse gas impacts, they seek emission reduction methodologies to align their operations with environmentally responsible goals. **Motivated by a growing market and the opportunity to improve our environment, innovators are hard at work developing new technologies for a sustainable future. GEC provides capital to these innovators, allowing them to scale solutions that help customers reach their clean energy commitments.**

Contact GEC to learn more:

www.geclp.com or +1.713.993.7222

[i] United Nations Economic Commission for Europe https://unece.org/challenge

[ii] EPA, Understanding Global Warming Potentials https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

[iii] IEA, Methane Tracker, 2020 https://www.iea.org/reports/methane-tracker-2020

[iv] Driving Down Methane Leaks from the Oil and Gas Industry: A Regulatory Roadmap and Toolkit https://www.iea.org/reports/driving-down-methane-leaks-from-the-oil-and-gas-industry

[v] IEA (2021), Methane Tracker Database, IEA, Paris https://www.iea.org/articles/methane-tracker-database

[vi] IEA (2021), Methane Tracker Database, IEA, Paris https://www.iea.org/articles/methane-tracker-database

[vii] Enverus.com data.

[viii] "Waste Not: Common Sense Ways to Reduce Methane Pollution from the Oil and Natural Gas Industry," 2015.

[ix] EPA presentation "Greenhouse Gas Reporting Program Petroleum and Natural Gas Systems," November 2019.

[x] "EPA Phase II Aggregate Site Report," Clearstone Engineering, March 2006.

[xi] GEC analysis and "Assessing the Methane Emissions from Natural Gas-Fired Power Plants and Oil Refineries," Lavoie et al, *Environmental Science and Technology* (February 2017) and EPA GHGRP 2019, https://ghgdata.epa.gov/ . Reported in carbon dioxide equivalents applying methane's 20-year GWP of 84.

[xii] Greenhouse Gas Equivalencies Calculator, EPA.gov.