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Tackling the oil and gas industry's methane challenge

In collaboration with GRANDPERSPECTIVE

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Methane is produced by virtually every oil and gas project worldwide, either as a by-product of oil production or directly from gas or gas condensate reservoirs.

The vast majority of methane produced globally is sold as natural gas. The industry's challenge lies in its emissions of the gas, intentionally or not, directly into the atmosphere. We class these emissions into two broad categories:

Super-emitter events: Commonly understood as emissions exceeding 10,000 kg/hour. Accidental examples include pipeline or storage tank ruptures, while intentional operational events include direct venting (effectively unlit flares) or incomplete combustion.

Snowballers: Small-scale operational emissions that come from innumerable sources that have a huge cumulative effect. These sources include leaking valves, pneumatic devices, venting from tanks and wellheads, and incomplete combustion in generators and flare stacks.

No single existing technology is able to provide complete coverage or granularity on methane losses. Even the most proactive oil and gas companies probably still underestimate the true extent of avoidable methane losses, making better emissions measurement options to support mitigation even more urgent.

For "super-emitter" events, this is less of a problem, as existing satellite technology is sufficient to detect and measure large methane releases. The challenge is how to stop them. Greater political will is needed to end strategic, wilful venting through rigorous regulation and penalties.

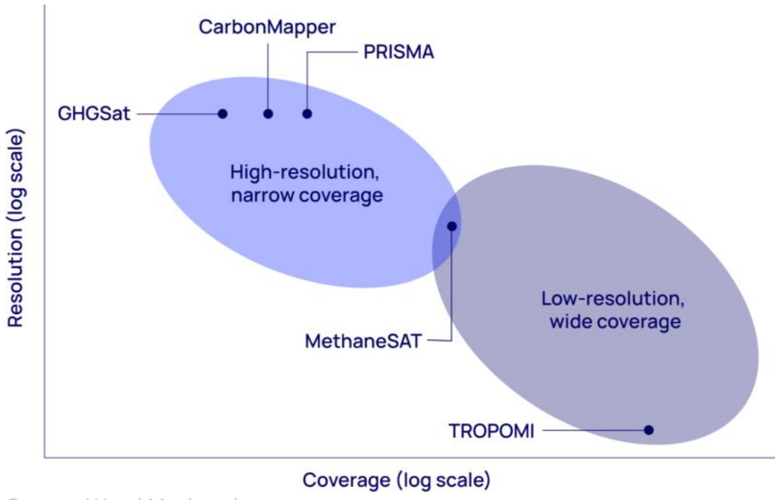
Improved detection and data accuracy are key to addressing "snowballing" smaller leaks. Upstream operators currently use six main monitoring approaches to record emissions: satellites, aircraft, drones, regional sensors, point sensors and, most commonly, optical gas imaging (OGI) cameras. Remote locations and the scale of operations can make this difficult. For example, full coverage of the Permian Basin would require a distributed network of small, precise meters across thousands of wells and kilometres of pipeline – with prohibitive costs.

The role of satellites in measuring methane

As emissions regulations tighten, there is an increasing focus on satellite technology to support more accurate and timely measurement of methane. There remains a significant gap between the spatial, spectral and temporal resolution of today's satellites and what is required.

There are currently three main classes of GHG-monitoring satellite. The first, and oldest, provides high-quality data on average GHG concentrations in large geographic regions. The second, not yet operational class, covers regional-scale emissions, and the third focuses on point-source emissions, often at the expense of wider coverage.

Current and planned methane-monitoring satellites



Source: Wood Mackenzie

The first class-two satellite launched in March 2024: the Environmental Defense Fund's MethaneSAT. It will track emission rates and locations and changes over time, making it easier to measure performance against legal and voluntary targets and prioritize solutions for maximum benefit. It should capture 80% of global oil and gas production and will detect both concentrated point emissions sources and dispersed area sources to quantify total emissions,

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something not possible with the previous class of satellites.

With limitations to all three classes, more precise and regular methane measurements are needed to assess routine methane loss from all oil and gas facilities.

A key determinant in those assessments will be the average level of emissions from a typical field. We estimate methane emissions in our Emissions Benchmarking Tool. Typical methane losses per field are small — less than 500 kg/hr (around 0.65 mmcfd), which is below the measurable resolution of most current satellites – but around 96% of all fields have emissions on this scale, making it a large, cumulative problem. More significant emissions from larger fields are often spread across multiple production facilities, making them harder to quantify.

The future of methane detection and monitoring

Consistent methane monitoring through satellites presents several challenges. Geostationary satellites can provide images with high temporal frequency, but a dedicated GHG Geostationary sensor is not yet operational. Orbital satellites provide near-global geographical coverage, but the lower frequency of their measurements over a particular point limits the data's applicability for user cases such as consistent monitoring and regulatory enforcement.

Methane is also highly dispersible; a methane molecule can travel from North America to South Asia in less than two weeks. Frequency gaps, therefore, make it difficult to track the source of methane. Translating any satellite imaging into facility-level emissions data also requires a sizeable, continuous amount of granular weather and atmospheric measurements on the ground.

Additionally, current satellite technology has trouble detecting methane emissions in offshore operations. Satellites use spectrometers to measure different molecules in the atmosphere by observing levels of surface-reflected solar energy absorbed at different electromagnetic wavelengths. However, the poor reflectivity of the ocean surface renders the observation of offshore facilities particularly difficult, though not impossible. As more advanced satellite instrumentation becomes mainstream, both onshore and offshore emissions will be able to be monitored to a comparable degree of accuracy.

Current and near-future innovations in satellite technology will allow "low hanging fruit" super-emitter events to be identified and monitored. However, space-borne technology is still a far way off being a complete solution for total methane emission observation. In order to deal with the smaller-scale snowballing emissions, innovations closer to ground-level may provide the solution.

Filling in the gaps: ground-based detection of methane emissions

Currently, ground-based identification and mitigation of methane emissions from oil and gas infrastructure is commonly carried out via Leak Detection and Repair (LDAR) surveys. The approaches to such surveys vary from basic detection of large leaks using OGI cameras (Type 1 LDAR), to higher sensitivity detection and quantification of smaller leaks using trace gas spectrometers (Type 2 LDAR).

Routine LDAR surveys are now officially mandated by many regulating bodies, yet existing protocols only require repeat surveys every few months to a year. Ground-based LDAR therefore suffers from similar coverage issues that are present in satellite observations; leaks may go undetected and therefore unabated for many months. More basic LDAR techniques may also lack the sensitivity to pick up smaller leaks, further leading to methane emissions flying under the radar. New innovations that allow continuous, automatic detection of leaks may provide the solution to these shortcomings.

While legacy sensors are largely ineffective at detecting methane and other gases efficiently and continuously, due to their limited reach and lack of specificity, many industrial plants need to employ more sensors to identify hard-to-detect chemical compounds. But, it is worth noting that each sensor adds an additional layer of complexity to process safety. In the case of simple gas sensors and unsophisticated analysers, this often means that the operating teams have to handle a greater number of false alerts. Often, the cost/benefit is not sufficient to justify the employment of these legacy sensors.

There is however a new generation of continuous monitoring sensors on the ground, that can provide good cost/benefits; one example is hyperspectral imaging based on Fourier-Transform infrared (FTIR) remote sensing technology. Grandperspective GmbH's sensors. Grandperspective's remote scanfeld® sensors are able to continuously and autonomously identify, monitor and quantify hundreds of gases at detection rates of 0.05 kg/hr or less - across a radius of one square kilometre. This is far more accurate than satellite limits of detection, which typically exceed 50 kg/hr.

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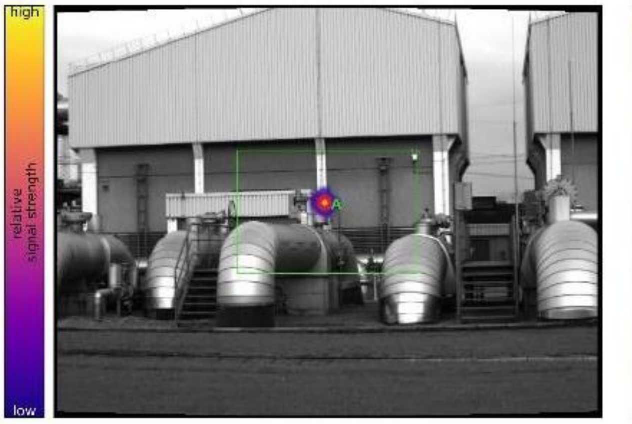
scanfeld® emission detection image of a simulated 50 g/hr methane leak



Source: Grandperspective GmbH

Oil and gas producers must turbocharge abatement

As measurement improves and becomes less costly, the ability and willingness of both companies and governments to tackle methane will be highly influenced by the 'what' and the 'where' of emissions. There is a direct commercial imperative to act in regulated environments where carbon or methane costs apply. The incentives might be less obvious elsewhere, with little or no government push.

Action on methane remains one of the most achievable ways for oil and gas companies to make a sizeable dent in their scope 1 and 2 emissions. OGCI member companies have already reduced upstream methane intensity by nearly 45% in the past five years. However, the whole industry must grasp the nettle to have real impact.

1. Monetisation

Companies' immediate focus should be on getting captured emissions into the sales stream. Additional revenues can help offset abatement costs. However, the cost of addressing methane leaks is often greater than the revenue loss and leaves companies with insufficient incentive for action. Proactive upstream players can work with third-party midstream providers to avoid flaring and venting. Tougher regulation, including carbon prices and specific charges for methane leaks, will encourage operators to access markets by investing in domestic or export infrastructure.

Methane reduction as a service may also have a future. This is currently monetised in the relatively uncertain offset market amid growing interest. The American Carbon Registry recently published a methodology to generate offsets from plugging methane leaks resulting from orphan and abandoned oil and gas wells. While prices for these offsets remain low, as more stringent regulations come into play those offsets should become more valuable.

Advocating for additional financial incentives can be effective. Gas buyers are becoming increasingly focused on the methane emissions associated with their energy supplies, and the UN Environment Programme has proposed a methane supply index to allow gas buyers to understand associated methane emissions. Operators in the US and Europe are already successfully negotiating premium pricing for certified low-methane-emitting production.

2. Deployment of known solutions

Doubling down on existing mitigation efforts brings immediate benefits. Most methane reduction methods using existing technology and equipment are relatively simple and cost-effective. Reducing venting and flaring is an urgent task that does not require technological improvements and is fairly straightforward if operators have access to infrastructure, gas markets and incentives.

More regulatory support will be required in hotspots such as Africa, Russia and Asia. For routine operational emissions, progress can easily be made by better monitoring for leaks, tightening valves and swapping out high-bleed devices.

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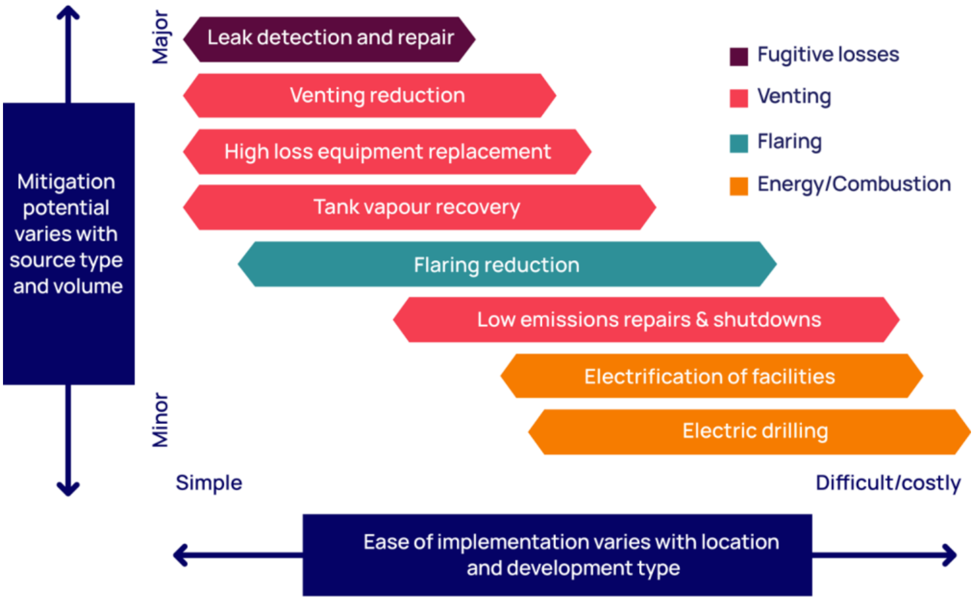
3. Partnerships and collaboration

Groups advocating for rapid methane reductions, such as the UN, the OGCI and the Methane Guiding Principles, are leading the way on best practices, but need broader participation. OGCI members include most of the world's largest upstream companies but represent only a fraction of global emissions.

The industry must work with joint-venture partners and others to expand efforts. For example, the Majors' operated methane targets exclude the 41% of their portfolios operated by others. Widening this to include non-operated assets would improve monitoring and spread resources and costs. More transparency on best practices and the participation of non-industry partners would lead to more efficient research and development. This could help shift the emphasis from 'naming and shaming' to collaborative innovation on cutting harder-to-abate emissions.

Industry methane targets should also be overhauled. Currently self-set and self-monitored, there are multiple methodologies, timeframes and goals. The upstream sector would benefit by working together on target setting; so far only the Majors have signed-up to standardisation.

Identifying sources and quantifying volumes will guide mitigation strategies



Source: Wood Mackenzie

Governments must step up to the plate

Similarly, government action will be vital to reducing methane losses. We see at least two high-level actions that could stimulate more progress globally.

1. Greater ambition and consistent enforcement

Voluntary pledges can only take the world so far. Ambition must translate into implementable and enforceable policy. An obvious starting point is global collaboration on stopping all large-scale flaring and venting of methane. Efforts in the US and Europe to address small-scale methane leaks are touted as positive steps but must go further.

Lofty targets and financial penalties for non-compliance are meaningless unless effectively enforced. Sidesteps and loopholes must be closed. Policymakers and regulators must also collaborate with industry to set realistic targets and timelines for emission reductions while ensuring that fees and fines are levied appropriately.

2. Financial support for technology

Governments should support funding to improve both measurement technology and abatement solutions. As part of the US IRA, US$350 million in funding is available to help monitor and reduce methane emissions, while in Canada, the CleanBC Industry Fund has granted Cdn$113 million for decarbonisation initiatives.

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Conclusion: time for decisive action

Tackling methane emissions is now among the oil and gas industry's top priorities. There is no reason to delay: existing, low-cost methods to curb emissions already offer effective solutions for smaller leaks even as the measurement of losses and tighter regulations advance.

No single existing technology is able to monitor the full extent of methane emissions on an asset level basis. Satellites provide unprecedented transparency in emissions reporting, uncovering super-emitters that previously would've gone undetected. But suffer in terms of coverage and detection limits. New innovations in ground-based detection can shed light on smaller emissions that are currently undetectable from space, but the benefits of such systems require direct company opt-in over all assets for full coverage. Both technologies are needed to ensure that methane emissions are better understood and mitigated by oil and gas operators.

Governments must also step up. An obvious start will be greater support for routine super-emitters to end large-scale venting. Tougher penalties for routine leaks would also push the industry to move faster. Incentives can help, with companies transforming methane losses into higher revenues and premium prices for certified low-methane supply.

None of this will be achievable without improved detection and data accuracy. Better measurement makes for better regulation and more effective mitigation. Tracking and tackling methane have never looked more urgent.

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