GRANDPERSPECTIVE

White paper

The energy sector is using state-of-the-art methane leak detection technology to reduce emissions.

Abstract

This white paper examines the escalating concern regarding methane emissions and their substantial contribution to global climate warming.

It will highlight that conventional methane detection sensors are often unable to provide the required quantitative data, which may be necessary for future compliance.

With the European Union and the United States both grappling with rising methane emissions, this paper explores how innovative technologies, specifically Fourier Transform Infrared Spectroscopy (FTIR) and Lidar, are revolutionising methane leak detection in the energy sector.

It will showcase illuminating case studies revealing how pioneering companies are using these leading-edge methane detection technologies to good effect.

The central case study will demonstrate how Fibrant, a leading chemical producer, has successfully proven a generational leap in safety system and gas leak technology, which it plans to roll-out universally.

The paper concludes by emphasising the consensus among leading industry experts that FTIR spectroscopy and Lidar will assume a more prominent role in the future of methane leak detection monitoring.

Introduction

Methane emissions are a significant contributor to climate warming, with the European Commission (EC) stating that they account for around a third of all current climate warming.

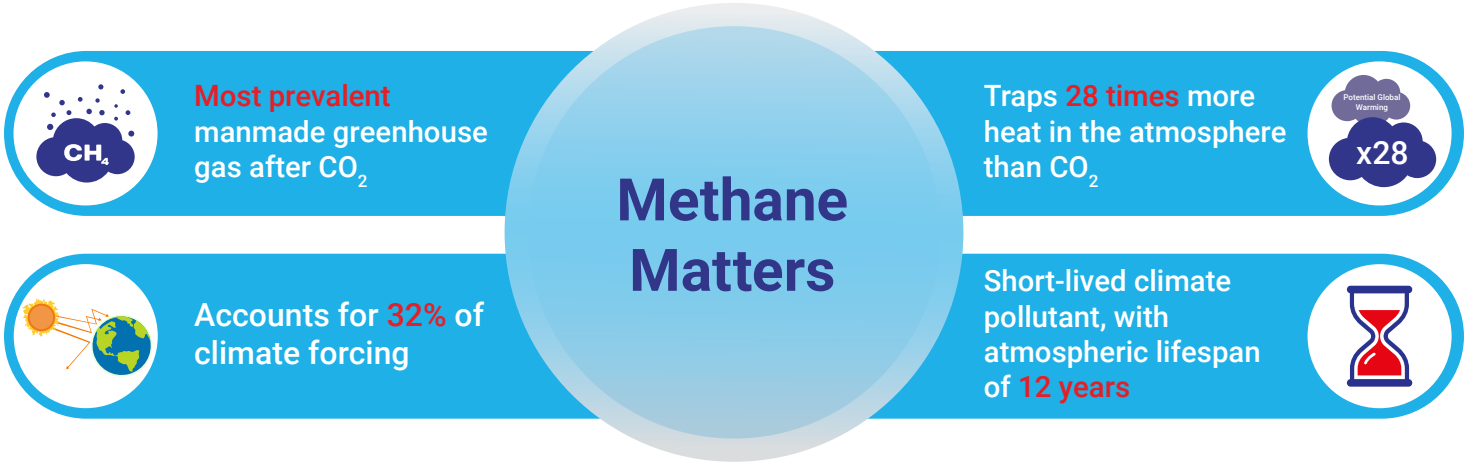
Research published by the EC revealed that over a twenty-year period, methane has a global warming potential many times greater than carbon dioxide.

In the USA methane emissions are on the rise. A study conducted by the Environmental Defense Fund, a non-profit environmental advocacy group revealed that “methane emissions were 60% higher than the government estimate”.

But there is some disquiet that conventional sensors, including Optical Gas Imaging technology, won’t be able to provide the quantitative data required to satisfy the upcoming enhanced regulations, which, in two years time, will require all European facilities to carry out a total top-down assessment of all site emissions.

Infographic: Methane: the facts

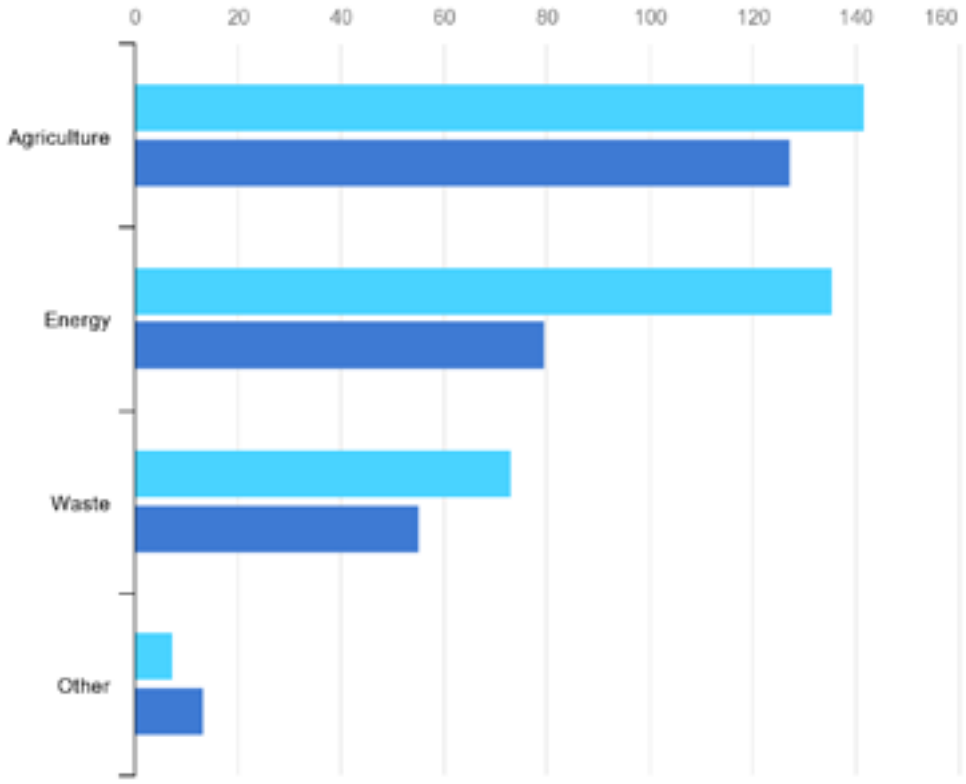
Diagram 1



Source: The Global Methane Initiative

Diagram 2

Global methane emissions by sector reported to the UNFCCC and estimates from the IEA, 2021.

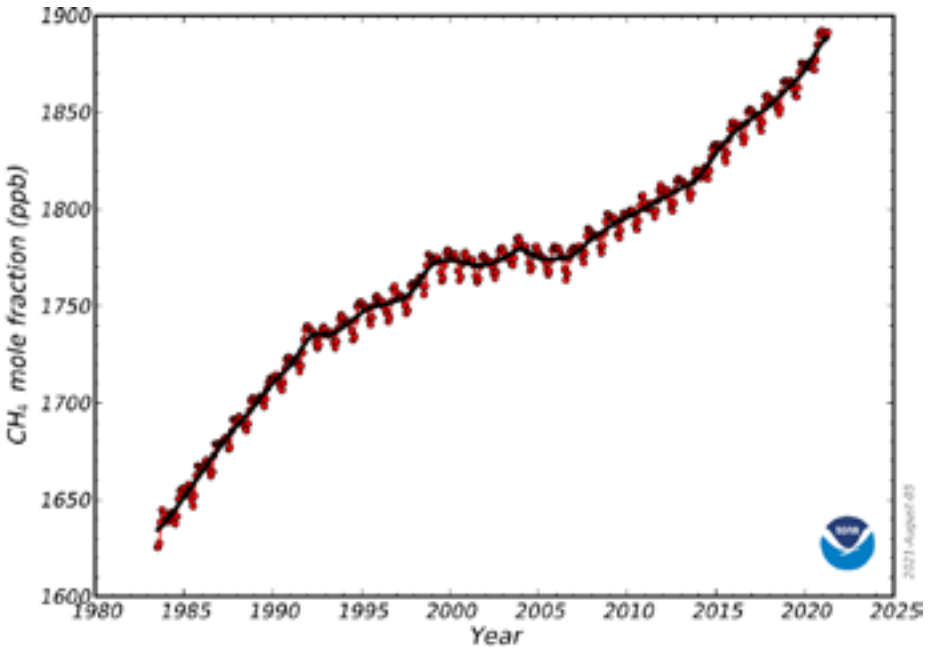


Source: International Energy Agency, Global Methane Tracker 2022

Upcoming Regulations and Challenges:

With methane emissions increasing in 2020 “at the fastest rate since records began” according to the Oxford Institute for Energy Studies (OIES), the Intergovernmental Panel on Climate Change (IPCC) says that methane emissions must be reduced by a third by 2030, and by 45 percent a decade later.

Annual trend in atmospheric methane concentrations 1980 - 2020



Source: National Oceanic and Atmospheric Administration (NOAA) 2021.

In the European Union, enhanced regulations are expected to demand top-down quantitative measurements for all methane handling infrastructure.

However, pioneering petrochemical plants are already taking decisive steps to limit methane emissions.

Conventional sensors are sometimes not capable of accurately detecting, quantifying and monitoring methane emissions.

“Methane’s spectral signature is in a much higher frequency range than gases such as ammonia and ethylene. To ensure an accurate reading, optical detection systems, or standoff sensing systems, must also compensate for humidity and temperature, which is beyond the capability of most conventional sensor technology.”

Dr Therese Keck
Chief Data Scientist,
Grandperspective GmbH

FTIR Spectroscopy

Fourier transform infrared (FTIR) spectroscopy, exemplified by the scanfeld® system, which is the brainchild of Grandperspective GmbH, a Berlin-based start-up, directly tackles the limitations of conventional sensors.

Unlike traditional sensor monitoring systems, it is able to accurately detect, identify, and quantify a wide range of gases, including methane.

But how does FTIR spectroscopy technology provide more accuracy and visibility than traditional systems?

The system, which is capable of detecting and specifying over 400 different chemical compounds, can analyse the chemical composition of a remote gas cloud in the air.

Dr. Keck says, “This is quite a breakthrough as our software and data analysis team are now able to capture the image of the cloud using 5D imaging. It means that we can accurately pinpoint the location of a potential leak to the extent where we would know exactly who was at risk and who was not.”

René Braun
CEO and founder of
Grandperspective GmbH

“Imagine combining a super-strength surveillance camera, which can see a kilometre into the distance, with the analytical power of a laboratory spectrometer. The spectrometer analyses infrared radiation, and in the same way finger-print detection technology identifies an individual, the scanfeld® system will forensically reveal the exact type and quantity of chemicals in the air, whether it is methane, or hundreds of other gases.”

Case Studies:

Background

Real-world analysis and testing demonstrates the value of new safety system

Fibrant, a leading chemical producer, has successfully proven a generational leap in safety systems and gas leak detection technology, which it now plans to roll-out universally.

Two years ago, Fibrant, which is the largest Caprolactam and Ammonium Sulfate producer in the world, began trialling a state-of-the-art gas detection system in collaboration with two major chemical producers, OCI N.V. and AnQore B.V., while Grandperspective, a Berlin-based technology start-up, provided the cutting-edge sensor and monitoring technology.

As part of the pilot, Peter Schmitz, formally of OCI, and now head of Fibrant's Process Safety Team, set up five state-of-the-art remote sensors across the three plants, which are located in the Chemelot Industrial Park in the southern Netherlands.

The scanfeld® system, which is based on Fourier transform infrared spectroscopy (FTIR), and was created and developed by Grandperspective GmbH, enables Fibrant to accurately detect, identify and measure - not just methane - but any gas emission.

Schmitz, Fibrant's Health, Safety, Environment and Quality Manager (HSEQ), explains, "We chose Grandperspective's scanfeld® technology, because unlike conventional approaches to gas detection, our test and analysis has shown that its industry-leading monitoring system to be highly successful in finding and tracking gas releases."

"It is absolutely critical that we are able to monitor emissions at every stage of the petrochemical process. However, to comply with future regulations, we must be able to forensically quantify and locate emission hotspots. We could install Optical Gas Imaging (OGI) cameras that would provide us with real-time visibility. But, as high-tech as those cameras are, they are not able to distinguish reliably between methane and water vapour. So, they are just not fit for 24/7 monitoring purposes. Remote sensors equipped with FTIR spectroscopy, on the other hand, can not only differentiate between methane and other chemicals, but can deliver highly accurate measurements over a vast distance. That's why we use FTIR spectroscopy."

Peter Schmitz
HSEQ Manager, Fibrant

Robust testing environment demonstrates the value of new safety system

Fibrant's Process Safety team ran rigorous field trials, which empirically proved that the sensors could not only detect gas leaks at ground level, but also potentially those which were out of the range of conventional ground-based sensors.

During the trials, Fibrant's safety systems were also able to accurately pin-point the source of a potential leak, while measuring the duration and the total loss.

Schmitz says, "This technology is a game-changer for the chemical industry and for our site, which is closely located to a major urban population centre. Unlike traditional sensor systems, this technology will enable much more precise and immediate monitoring than is conventionally possible."

The significance of this breakthrough for risk mitigation is not lost on Schmitz, who says for the first time, chemical plants "can issue tailored and targeted warnings by creating a real-world picture who is, and who is not at risk."

He explains, "The technology is revolutionary as the test configuration data demonstrates that process safety teams will be able to better co-ordinate their evacuation mitigation measures much more accurately.

He continues, "Our tests show that the technology will allow process safety teams to track the real-time movement of a potentially harmful gas cloud. In doing so, they will be able to quickly and accurately identify who is, and who isn't, at risk in a multi-storey building.

Lidar Technology for Pipeline Monitoring

Matthias Ulbricht
CEO and founder of ADLARES

"In terms of pipeline monitoring, Lidar technology is by far the most accurate and efficient way to detect small leaks mainly caused by third party intrusions – for example, excavators."

Case Study:

ADLARES and CHARM® System partnered with Open Grid Europe (OGE) to develop the CHARM® gas detection system. This innovative Lidar-based solution offers highly accurate methane measurements, even in challenging scenarios such as pipelines running beneath farmland.

After founding airborne leak detection company, Matthias Ulbricht, an expert in industrial Lidar detection applications, created and developed the CHARM ® gas detection system with OGE, a transmission grid operator, which is responsible for 12,000 kilometres of gas pipeline in Europe.

The CHARM® gas detection system uses a high-tech scanner, which when mounted on a helicopter, provides clients with far more accurate methane measurements than any thermal imaging camera is able to deliver.

Since, 2008, he says "helicopters", which fly at between 100 to 180 kilometres per hour and cover up to 500 square kilometres in a day, have inspected "over 100,000 kilometres of gas pipelines for various gas grid operators across Europe", including, but not limited to, Transmission System Operators (TSO) such as OGE, ThyssenGas and Fluxys.

CHARM ®

So how does this Lidar solution, which can also identify ethylene leaks, work? Ulbricht explains, "The CHARM® system is equipped with a high-power laser, which transmits two laser pulses towards the ground. The laser pulses scatter. If no methane is detected, when the pulses return to CHARM®, the signal from both pulses will be the same. However, if methane is found, the first pulse will be partially absorbed by the methane and we will receive a much weaker signal compared to the second laser pulse."

But what makes the technology solution developed by ADLARES and OGE unique is its innate ability to differentiate between pipeline related emissions and non-pipeline related emissions. This is made possible by ADLARES's and OGE's leading-edge data post-processing system.

With pipelines often running directly underneath farmland containing large populations of cattle, the ability to decipher methane leaks from fossil fuels and leaks created by a herd of digesting cows is absolutely crucial.

"To ensure we can do this, we have developed an onboard plume recognition algorithm," says Ulbricht, "which can identify a methane leak from a gas pipe and notify the operator in real-time. If there is a man-made methane leak, which is small, as most are, we will send a report to the client, which includes coordinates, pictures and a digital map of the leak site."

Comparative Analysis: FTIR versus Lidar versus Satellite

A comparative analysis of FTIR, Lidar and Satellite technologies demonstrates the fact that each one has its own individual strengths in different scenarios. While FTIR is suitable for permanent on-site solutions, Lidar excels in fly-over inspections of extensive pipeline networks. Satellite technologies, in contrast, can work in a range of different scenarios, but ultimately, they may struggle to fill future top-down emission assessments.

"FTIR spectroscopy and Lidar applications have much in common. They both enable a top-down approach when it comes to assessing total site emissions. The only difference is that our technology is best utilised for facilities that require an automated, permanent on-site solution, whereas ADLARES's technology is better suited to sites and pipeline networks where a fly-over inspection approach is the only way to deliver effective methane monitoring."

René Braun
CEO and founder of
Grandperspective GmbH

Peter Schmitz
HSEQ Manager, Fibrant

"There are satellites used to find super emitters. But for reliable quantitative measurements - 24/7/365 days a year, continuous on-site monitoring by FTIR spectroscopy gives us a much more accurate picture than satellite technology. Such systems could only provide us with one measurement a day. At Fibrant, we think that's just not good enough. We need 24/7 remote ground sensing coverage and FTIR spectroscopy delivers on that continuous monitoring requirement."

Expert Perspectives and Future Trends:

Independent experts predict that future regulations will demand more rigorous and accurate assessments of methane emissions. However, they say that there will also still be a place for conventional sensor technologies.

In summary, satellite technology, while useful for detecting large-scale emissions, may prove to be inadequate for precise measurements. FTIR and Lidar technologies, however, are likely to play increasingly significant roles in methane emission monitoring.

Dr Jasmin Cooper
Research Associate for the Sustainable Gas Institute (SGI) in Imperial College London

"Future regulations in the EU and the USA around methane emissions are likely to be much more rigorous and robust than they are now. It could be that they will require energy companies to carry out top-down assessments of their total site emissions.

If so, in theory, satellite technology could perform this role, but in reality, it cannot provide accurate top-down measurements. This is because a satellite measures the concentration of methane in a single pixel, and the typical pixel size spans areas of hundreds of square metres to tens of square kilometres. This means that while satellites are very good at detecting large-scale methane emissions, they aren't best suited to identifying the escape of methane in petrochemical plants, or from pipelines.

Both FTIR spectroscopy and Lidar technology, which have lower detection limits, may, however, be able to provide a more detailed and accurate picture of the methane emissions landscape."

Conclusion:

The limitations of traditional methane detection monitoring systems highlight the need for advanced technologies like FTIR spectroscopy and Lidar. These remote sensing technologies not only provide accurate measurements but also offer solutions to a myriad of different methane emission – and other gas - detection scenarios. As regulations tighten, this pioneering technology could prove an indispensable tool in significantly detecting, tracking, monitoring, and ultimately, reducing methane and other gas emissions.

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