Zero Carbon Analytics

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Why measuring methane matters

Key points:

- Oil & gas companies typically rely on component-based inventory methods to estimate methane emissions over time which do not account for large-scale leaks.
- The methodology used for estimating methane emissions was developed by the oil and gas industry and has been found to under-estimate methane emissions at a global level.
- Methane emission rates reported by major oil and gas companies are 94% lower than indicated by independent estimates of the sector's emissions.
- The potential significant discrepancies between companies' reported emissions and independently assessed emissions at a global level raises questions for investors and regulators regarding the reliability of oil and gas companies' claimed emissions reductions.
- Emissions accounting methods should be updated to include site-based measurements to understand the true magnitude of methane emissions.

Oil & gas industry is a major methane emitter

Methane is a potent greenhouse gas, with a warming impact nearly 30 times greater than carbon dioxide over a 100 year period. Methane emissions are responsible for around 30% of the rise in global temperatures, according to the International Energy Agency (IEA). The oil and gas industry accounts for around a quarter of global methane emissions, second only to agriculture. Methane leaks or is released throughout the oil and gas supply chain – from extraction, processing and transport to use.

Reducing methane emissions from the hydrocarbons sector is crucial to meeting climate goals. The IEA estimates that achieving a 75% reduction in emissions from fossil fuel operations would satisfy most of the 30% reduction in global methane emissions by 2030 targeted by the Global Methane Pledge.

The first step to effective mitigation is to accurately measure the size of the problem. In recent years, advances in satellite imagery and remote sensors have enabled the identification and quantification of large methane-emitting sources globally. The use of these advanced methods has revealed that methane emissions are significantly higher than what has been historically reported based on estimation techniques.

The problem with current methane estimates

Methane emissions can be measured using new technologies to gather emissions data in real time. These can be classified as bottom-up (e.g., emissions measured at a facility) or top-down (e.g., facility emissions observed using satellite imagery).

By contrast, methane emissions can be estimated by using a set of assumptions about the equipment used - known as a 'component by component' approach. This methodology uses a bottom-up analysis to generate the rate at which an individual activity or component leaks methane into the atmosphere, known as the 'emission factor'.

Once an emission factor has been established for each component within a project or piece of infrastructure, it is multiplied based on the level of activity at that project (e.g. the amount of oil and gas being extracted) to estimate the emissions produced in a given time period. These are then combined for all activities and components in a project to produce an estimate of its total methane emissions.

Research studies have identified that emissions measured using bottom-up and top-down approaches are consistently higher than those obtained through national reporting frameworks that rely on component-by-component estimations:[1]

- A study comparing upstream oil and gas emissions in the UK found the government's National Atmospheric Emissions Inventory (NAEI) was five times lower than estimates based on direct measurements.
- A major study in the US in 2018 reported that emissions estimates from direct measurements were 60% higher than those derived from the US Environmental Protection Agency (EPA) greenhouse gas (GHG) inventory.
- A larger subsequent study in 2024 using aerial measurements found that methane emissions in the US were on average roughly three times higher than the EPA inventory estimate - and equivalent to the emissions from Mexico's use of fossil fuels.

The significant discrepancy between reported emissions and those produced by independent estimates calls into question the accuracy of the emission factors used.

A notable constraint of estimating emissions through component-based emission factors is that they neglect to consider the distinctive characteristics of individual assets and their actual operations over time. Sampling measurements used to establish emission factors typically fail to capture abnormal high-emitting events.

These rare events, commonly known as super-emitters, have been estimated to contribute as much as half of total emissions from natural gas production sites. Although the exact source of emission discrepancy may vary from one asset to another, super-emitter events serve as a prime example of why real-time measurements are indispensable for understanding the performance of an asset.

How big is the difference?

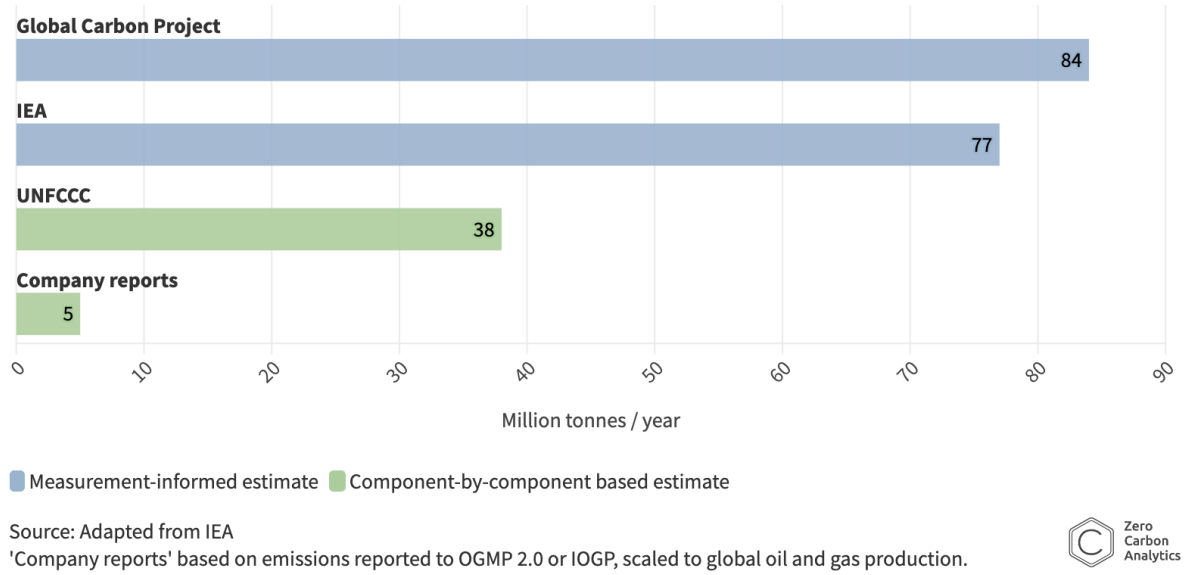
The Global Carbon Project, a non-governmental global research project working to quantify greenhouse gas emissions, and the IEA estimate oil and gas methane emissions at

[1] See Alvarez et al 2018, Riddick & Mauzerall 2022, Zavala-Araiza et al. 2015, Riddick et al. 2019, Chen et al. 2023, MacKay et al. 2021

80 and 77 million tonnes per year, respectively, using a mix of ground-based measurements and satellite data.

These figures are more than double the United Nations Framework Convention on Climate Change's (UNFCCC) estimate of 38 million tonnes, which relied on country-level self-reported data. This discrepancy highlights a gap between the reporting frameworks used by national governments to estimate their emissions from the oil and gas sector and their real world emissions.

Fig. 1: Estimated methane emissions from the oil and gas industry



Source: Adapted from IEA
'Company reports' based on emissions reported to OGMP 2.0 or IOGP, scaled to global oil and gas production.

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Oil and gas companies also frequently rely on methodologies consistent with those used by governments to submit estimates to the UNFCCC.[2] However, recent analysis by the IEA has shown that companies' reported emissions may be dramatically under-estimating total emissions. More than 80 companies reported 1.3 million tonnes of methane emissions to the Oil and Gas Methane Partnership 2.0 (OGMP 2.0), the United Nations Environment Programme's oil and gas reporting and mitigation programme. If this rate of leakage was scaled to all oil and gas production, the IEA calculated that this would equate to just 5 million tonnes, 94% less than the Global Carbon Project and IEA estimates.

The IEA suggests that the companies reporting to OGMP 2.0 may be the best-performing companies on methane emissions, and therefore might not be representative of the whole industry. However, it also highlights that as these company figures rely on emission factors they may be missing super-emitter events, which account for a large proportion of the industry's emissions.

[2] For example, the US EPA GHG Reporting methodologies are used to develop the GHG emissions national inventory https://www.epa.gov/ghgreporting/ghgrp-and-us-inventory-greenhouse-gas-emissions-and-sinks. For details of the EPA GHG use of emissions factors see https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-W

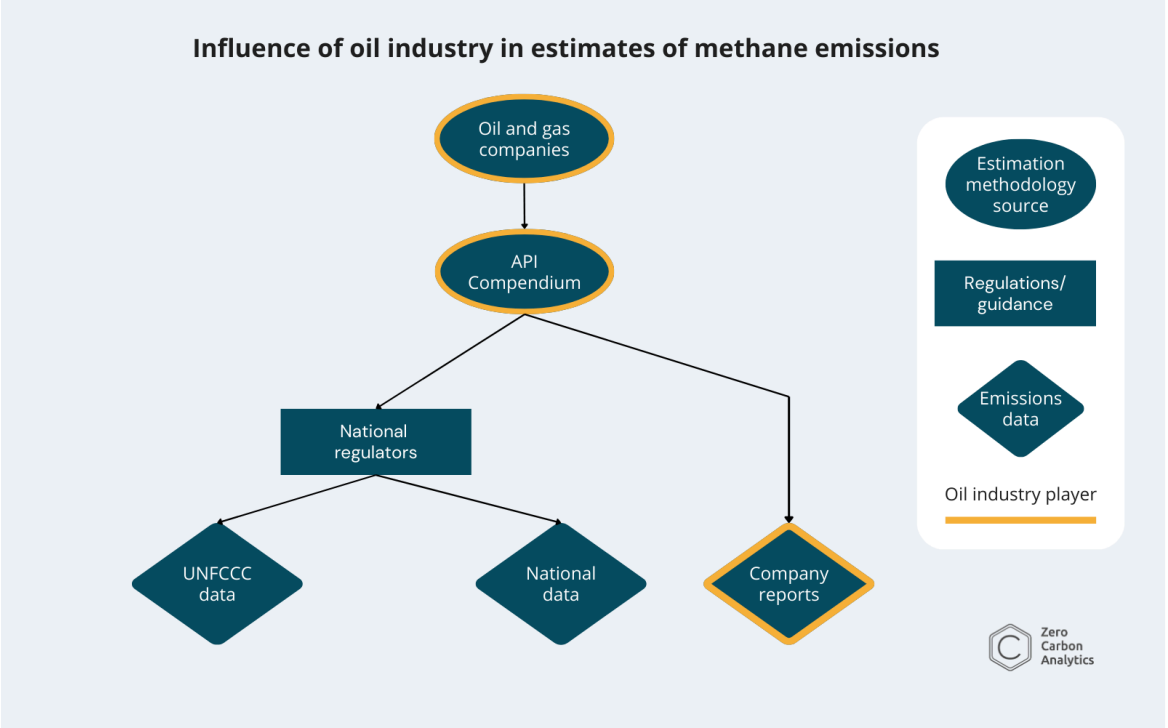
Identifying the source of emissions estimates

While not all major oil and gas companies disclose their emission-estimation methodology, national reporting frameworks such as the US EPA, EU Emissions Trading System Monitoring and Reporting Regulation, or the American Petroleum Institute Compendium of Greenhouse Gas Emissions Estimation Methodologies (referred to as the API Compendium) are frequently cited as a basis of estimations by sector players.

The API Compendium describes itself as a "foundational document to estimating GHG emissions from the oil and natural gas industry". The most recent edition of the API's guidance, released in 2021, was developed by a working group consisting solely of representatives of 19 oil and gas companies, including Exxon, Chevron, Shell and BP.

The API Compendium employs component-by-component estimates to calculate emissions, and is used by governments and state bodies, including by the US EPA, Australia and Canada, to produce national guidance on emissions estimates. These, in turn, are used by oil and gas companies to produce their reported emissions. A reliance on emission factors produced by the API may be resulting in a significant underestimation of the scale of the industry's methane emissions.

Fig. 2: Current methane emissions monitoring structures and players



Source: Zero Carbon Analytics

Why it matters

Accurately measuring emissions is crucial to ensure that ambitions to reduce methane in the atmosphere are aligned with actual levels.

The industry has promoted its own success through initiatives such as the Oil and Gas Climate Initiative (OGCI) whose 12 member companies claim to have reduced methane emissions by 50% since 2017 as of mid 2024.

While the OGCI is expanding its use of satellites to gather emissions data, the organisation's guidance to members for estimating GHG emissions allows for three methodologies: those based on measurements, calculations using emissions factors (including from API) and estimates. The body advises that, "Whenever economically and technically possible, the most accurate available category of quantification should be preferred".

While the OGCI members may continue to rely on calculations and estimates, it is not possible to confirm whether those companies have achieved the methane emission reductions they have claimed.

Industry's early steps

With companies still in the early stages of deploying technologies like site-based measurements, satellites and aerial surveys to detect methane emissions, it is critical that the real-time measurements obtained from these technologies be incorporated into emission estimates.

The industry is moving in this direction with initiatives like the OGMP 2.0, which requires companies to transition towards site-based measurements for both operated and non-operated assets.

This will be a slow process, with companies given between three and five years to move to site-based measurements for operated and non-operated assets, respectively, after signing up to the initiative.

What's needed next

As technology advances and climate change worsens, regulators and the scientific community will need better estimates of methane emissions to verify company and country reported emissions.

In light of the discrepancies between estimated and measured emissions, governmental regulators should re-examine the methodologies used by oil and gas companies to report their emissions. Where these rely on the API or other industry-led models and emissions factors, results should be reviewed by independent third parties to ensure their accuracy.

There are significant risks in public regulators relying on the industry to set the standards for measuring its impact on the climate. Ultimately regulators will need to shift to requiring oil and gas companies to report measured, rather than estimated emissions, to ensure they have accurate data to assess climate action within the sector.

Legislators and regulators in the US have already begun to identify and address the gaps in the current emission factor based framework, with the Inflation Reduction Act giving the EPA authority to fine oil and gas producers for methane emissions above a certain threshold. To do this, the EPA has adjusted its rules to calculate methane emissions within

its reporting framework. While this represents a step forward, regulators will ultimately need companies to provide solely measured emissions data to ensure accuracy.

For companies, improving knowledge of methane emissions from their assets is necessary to deliver emission reduction targets and effective management of their infrastructure. This requires a concerted effort to obtain quality data for non-operated assets and accelerate the transition to measurement-based initiatives.

The use of real-time measurements is critical in bridging the reporting gap and providing a better understanding of methane emissions from oil and gas infrastructure. Investors and regulators will need to treat industry-reported data on methane emissions and emissions reductions with caution when considering risk to climate targets.