Detecting and Quantifying Methane Emissions from the Oil and Gas Sector

Testimony of David Lyon, PhD, Senior Scientist, Environmental Defense Fund

Before the

House Committee on Science, Space, and Technology

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Chairwoman Johnson and Members of the Committee,

I am David Lyon, Senior Scientist at Environmental Defense Fund. I have spent the last decade researching oil and gas (O&G) methane emissions, working closely with experts in industry, academia, government, and other environmental organizations. Environmental Defense Fund is a non-profit, non-partisan organization with over 3 million members and 750 staff that uses science and economics to find solutions to the world's most serious environmental challenges including climate change. Methane is both the primary constituent of natural gas and a powerful greenhouse gas with over 80 times the warming potential of carbon dioxide over the twenty years following its release, responsible for one-quarter of today's global warming.[1]

The good news is that global temperatures in 2050 could be reduced by 0.5°F if methane emissions are cut in half by 2030, and the operating systems and technologies to do it are widely available now at little or no cost[1]. The O&G industry is the largest industrial source of methane emissions but also has the most cost-effective solutions since capturing methane often allows companies to sell more natural gas. Additionally, the methane mitigation industry provides many high paying jobs and is rapidly growing[2]. However, delaying the widespread adoption of mitigation measures will substantially worsen climate impacts and cause continuing harm to communities and workers.[1]

Although mitigating methane emissions is usually cost-effective, there are several challenges in detecting and quantifying emissions in the O&G industry. First, O&G infrastructure is widespread with diverse site types including wells, tank batteries, compressor stations, processing plants, and pipelines. About 80% of U.S. wells produce less than 15 barrels of oil equivalent per day; these wells account for just 6% of national O&G production but are responsible for half of all wellsite emissions due to their large number and high loss rates.[3] Second, peer-reviewed research has found that the top 5-10% highest-emitting sources typically account for over half of O&G methane emissions.[4] These sources, sometimes called super-emitters, can occur at almost any site, and their locations are difficult to predict, so all sites must be inspected for leakage.[5] Finally, there are many emission sources, particularly super-emitters, that leak for a few hours to days, stop, and then restart — therefore, leak inspection surveys may miss these episodic emissions if they happen to be observed in their "off state."[6]

Due to these challenges, the U.S. Environmental Protection Agency's Greenhouse Gas Inventory has been shown to underestimate U.S. O&G supply chain methane emissions by ~50% compared with a measurement-based study estimate of 13 million metric tons. That magnitude of methane emissions is equivalent to 2.3% of the country's natural gas production[7] and represents the waste of over $5 billion of a valuable natural resource.

There are numerous available and emerging technologies for detecting and quantifying emissions, which can be grouped into two general categories: wide-area screening and continuous monitors. Screening approaches typically use remote sensing technologies deployed on aircraft, drones, vehicles, or satellites to quickly inspect large numbers of sites for methane emissions[8]. Many of these approaches both quantify emission rates and generate an image of the methane emissions, which can help operators determine the exact source and cause of the leak.

Currently, most screening approaches have high detection limits and are only suitable for detecting super-emitters, but technological advancements are improving their ability to locate and quantify smaller sources – especially when different instruments and techniques are combined to provide multiple layers of information.

Screening approaches usually are followed up by ground-based leak detection surveys using instruments such as infrared optical gas imaging cameras that can locate both small and large leaks. Since many large sources are episodic, they may not be leaking during follow-up surveys. Therefore, it is critical that companies also perform a root cause analysis to determine if there are any equipment or operational issues that could lead to intermittent super-emitters and then make the necessary changes to prevent their recurrence.

In contrast to wide-area screening, continuous monitors are installed at a stationary location to monitor one or several nearby sites for emissions continuously or at a high frequency such as several times per day. Most continuous monitors use a combination of methane concentration sensors, wind monitors, and atmospheric science calculations to detect and sometimes quantify emissions, but some systems use remote sensing or continuous optical gas imaging. The biggest challenge with continuous monitors is to avoid false alarms and missed sources due to the complexity of distinguishing leaks from both onsite, permitted emission sources such as pneumatic controllers and offsite emissions from upwind sites. For both screening and continuous approaches, rigorous field testing[9] plus a clear understanding of how the technologies are incorporated into operator work practices is critical for their successful implementation.

EDF and our research partners including Pennsylvania State University, University of Wyoming, and Carbon Mapper have used several measurement approaches in the recent Permian Methane Analysis Project (PermianMAP), which measured methane emissions in west Texas and southeast New Mexico using tower- and aircraft-based quantification of total emissions over time, aerial and ground-based site level quantification, and qualitative optical gas imaging of flares and other sources. This data allows researchers to characterize emissions in the Permian Basin, compare performance by operator, and track changes in emissions over time. For example, total emissions temporarily declined in spring 2020 due to the COVID-associated oil price crash.[10] Emissions data are posted rapidly on a public website to help operators mitigate emissions and inform stakeholders about the magnitude and trends in methane emissions.[11] Several operators have noted that PermianMAP data has helped them reduce emissions and supported their own efforts using similar advanced technologies for emissions detection.

Federal agencies can effectively support research and implementation of methane detection, measurement, and mitigation technologies by funding two types of programs: 1) accelerating research and development of technologies including instruments and data analysis; and 2) collecting methane measurement data to better characterize emissions. Previous federal R&D efforts such as the DOE ARPA-E MONITOR program[10] have been highly successful and facilitated major improvements in several technologies. Additional funding could increase the diversity of available approaches and drive improvements in performance while reducing cost.

Agencies such as NOAA, NASA, and NIST could use multiple measurement approaches such as satellite remote sensing to annually quantify total and super-emitter O&G methane emissions in major U.S. basins, which EPA could then use to assess the accuracy of their Greenhouse Gas Inventory and prioritize updates[11]. Additionally, emissions data could be used by EPA to increase the efficacy and cost-effectiveness of O&G methane regulations, such as informing EPA's proposal to allow advanced screening for leak detection. This federally funded data likely would enable companies to reduce their emissions and publish their own measurement data to demonstrate when they have lower methane intensity than their peers[12], which would help domestic and international consumers make informed decisions when they purchase natural gas.

In summary, methane is a powerful greenhouse gas that is warming our planet, but there are many cost-effective solutions for reducing emissions, especially in the O&G industry. Advanced technologies have allowed operators and other stakeholders to better characterize emissions, including intermittent super-emitters that were overlooked by past methods. Federal agencies can accelerate methane emission reductions by both supporting research and development of detection, quantification, and mitigation technologies and implementing long-term research programs that use measurement data to track emissions over time. Reducing methane emissions from the U.S. O&G supply chain is an urgent and achievable solution that will benefit numerous stakeholders including O&G companies, workers, consumers, communities, and the environment.

Thank you for your time,

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Environmental Defense Fund

References

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EDUCATION

University of Arkansas, Fayetteville, AR
Ph.D. in Environmental Dynamics (May 2016)
- Dissertation: *Quantifying, Assessing, and Mitigating Methane Emissions from Super-emitters in the Oil and Gas Supply Chain*
- Honors: 4.0 GPA; Doctoral Academy Fellowship

University of Kentucky, Lexington, KY
M.S. in Forestry (May 2004)
- Thesis: *Persistent Effects of Eastern Redcedar on Calcareous Glade Soils and Plant Community*
- Honors: 4.0 GPA; Garden Club of America 2003 Fellowship in Ecological Restoration

Hendrix College, Conway, AR
B.A. in Biology with Chemistry Minor (June 2002)
- Honors: 3.95 GPA; Summa Cum Laude with Distinction; Phi Beta Kappa

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WORK EXPERIENCE

Environmental Defense Fund, Austin, TX
Senior Scientist (May 2021 – present)
- Lead EDF's Permian Methane Analysis project using multiple measurement approaches to quantify oil and gas methane emissions and rapidly publish data online
- Provide thought leadership on technologies and policies to detect, quantify, and mitigate oil and gas methane emissions
- Supervise scientific staff

Environmental Defense Fund, Austin, TX
Scientist (March 2014 – April 2021)
- Contribute to the design, planning, execution, and analysis of EDF-sponsored research studies on quantifying methane emissions from the oil and gas supply chain

- Advise internal and external projects on innovative approaches for leak detection and mitigation
- Prepare and review manuscripts for submission to peer-reviewed journals
- Communicate science and advocacy through presentations, briefings, and media interviews
- Provide scientific expertise to other EDF programs and external groups

Environmental Defense Fund, Austin, TX
Research Analyst (June 2012 – March 2014)
- Research, analyze, synthesize, and interpret data related to oil and gas methane emissions
- Analyze, interpret, and communicate data to policymakers, industry, the scientific community, and other stakeholders in support of EDF advocacy on environmental policy
- Write reports, blogs, and other communication materials for general audiences

University of Arkansas at Little Rock, Little Rock, AR
Part-time Lecturer (January 2012 – May 2012)
- Taught senior-level environmental science course *Fundamentals of Air Pollution*

Arkansas Department of Environmental Quality, North Little Rock, AR
Environmental Program Coordinator (January 2009 – May 2012)
- Obtained EPA funding, managed project, and authored report on a study to develop an emissions inventory and monitor air quality impacts of natural gas development in the Fayetteville Shale
- Managed $500,000 project to develop and implement a web-based emissions inventory reporting system for a multi-state consortium of environmental agencies
- Led the state's air pollution emissions inventory program, which included approximately 175 regulated facilities and several nonpoint emission source categories
- Analyzed emissions data and produced reports for the agency and public
- Analyzed current and proposed federal air regulations to assist agency planning
- Supervised up to four staff

University of Arkansas, Fayetteville, AR
Graduate Assistant (August 2004 – December 2008)
- Performed research on the effects of nutrient enrichment on stream carbon cycling
- Assisted students in general ecology laboratory

University of Kentucky, Lexington, KY
Graduate Assistant (June 2002 – June 2004)
- Performed research in restoration ecology and soil biogeochemistry of calcareous glades
- Taught dendrology and tree species identification to undergraduate students

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PUBLICATIONS

Lyon, D. R., Hmiel, B., Gautam, R., Omara, M., Roberts, K. A., Barkley, Z. R., ... & Hamburg, S. P. (2021). Concurrent variation in oil and gas methane emissions and oil price during the COVID-19 pandemic. Atmospheric Chemistry and Physics, 21(9), 6605-6626.

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