Oil and Gas Development: Impacts on Air Pollution and Sacred Sites

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Introduction

My name is David Lyon. I am a scientist at Environmental Defense Fund (EDF), a nonpartisan, nonprofit environmental advocacy organization with over 2 million members and 700 staff guided by science and economics to find solutions to urgent environmental problems. I have worked at EDF for almost 7 years researching methane emissions and other air pollution from oil and gas (O&G) development. I earned a Ph.D. in Environmental Dynamics from the University of Arkansas with my dissertation research on the quantification, assessment, and mitigation of O&G methane emissions.

I want to thank Chairman Grijalva, Subcommittee Chairman Lowenthal, and other members of the Committee for the opportunity to speak on the important issue of methane pollution from O&G development. In addition to being a powerful greenhouse gas that contributes about a quarter of current global warming, methane emissions are a consequence of industry failing to deliver a valuable natural resource to consumers. As I will cover in my testimony, O&G methane emissions are substantially higher than government estimates, but there are many cost-effective approaches that companies can implement to reduce emissions and improve operational efficiency.

Oil and gas methane emissions: A journey of scientific discovery

Methane is both the primary component of natural gas and a powerful but short-lived greenhouse gas with more than 80 times the global warming potential of carbon dioxide over a 20 year period.[1] Public interest in O&G methane emissions grew rapidly around 2011 when studies began posing questions about the climate impact of using natural gas to replace more carbon dioxide intensive fossil fuels such as coal.[2,3] At the time, there were little data available on methane emissions and almost nothing collected since the rapid growth of unconventional O&G development from horizontal drilling and hydraulic fracturing. As a science-driven environmental advocacy organization, EDF saw an opportunity to advance society's understanding of the magnitude and sources of O&G methane emissions and apply that knowledge to develop and implement cost-effective solutions to quickly reduce emissions. In 2012, EDF launched a series of 16 research studies to quantify methane emissions across the U.S. O&G supply chain. These studies involved over 140 experts from about 40 institutions and resulted in 38 peer-reviewed papers published in academic journals.

Today I will highlight a few major findings from EDF sponsored studies and other recent research on O&G methane emissions. Additional information on the EDF studies including links to the published papers can be found on our website.[4]

What is the magnitude of O&G methane emissions?

The current best estimate of U.S. O&G supply chain methane emissions is from Alvarez et al (2018), a peer-reviewed manuscript published in the journal *Science* by 24 co-authors including myself from EDF and 15 other organizations. This paper, which synthesizes data from EDF sponsored and other studies,

estimates that 2015 U.S. O&G methane emissions were 13 million metric tons.[5] Emissions occur across the entire supply chain from the wellhead to customer meter, but are dominated by upstream sources like well pads and gathering stations, which account for about 80% of sector wide emissions. In context, 13 million tons is 60% higher than the official estimate published by the U.S. Environmental Protection Agency in their annual greenhouse gas inventory.[6] These emissions are equivalent to 2.3% of gross natural gas production and about $2 billion in wasted product.[5] At this loss rate, methane emitted across the O&G supply chain almost doubles the short-term global warming of using natural gas for energy.[5] Or to express this finding in another way, the climate impact of natural gas could be cut in half by eliminating methane emissions.

In New Mexico, at least one million tons of methane are emitted from upstream O&G sites – this conservatively low estimate was recently published by EDF and based on data from Alvarez et al (2018) and new measurements from Permian well pads.[7] These emissions have the same short-term climate impact as 22 coal-fired power plants and could meet the annual heating and cooking needs of every home in New Mexico. EDF estimates the state is wasting $275 million worth of natural gas and losing out on an additional $43 million in tax and royalty revenue every year due to methane waste. And about 300,000 tons of volatile organic compounds (VOC) is co-emitted with methane, which can include hazardous air pollutants with local health effects. The highest emissions are found in the southeast of the state where the Permian oil boom has led to a massive increase in O&G development and flaring, but emissions remain high in the San Juan Basin where tribal communities are at risk from local air pollution.

<u>What insights have we learned about O&G methane emissions?</u>

During our research, we have learned three key insights with major implications for the quantification and mitigation of emissions: 1) O&G emissions are highly skewed with a relatively small number of sites contributing the majority of emissions; 2) traditional approaches tend to underestimate emissions; and 3) almost all emissions are can be reduced with cost-effective solutions.

In all studies of methane emissions from O&G facilities and equipment, a consistent finding has been that individual emission rates are highly skewed. This means that most sites or components have relatively low emissions, but there are some very high emitting sources that are responsible for a substantial portion of total emissions. A general rule is that the top 5 – 10% highest sources account for the majority of emissions in a category.[8,9] The identity of these high emitters is unpredictable – as demonstrated by a study I led that surveyed over 8,000 well pads across the U.S. with aerial leak detection.[10] And since high emissions can be caused by intermittent issues, different sites may be the worst offenders at any one time. This has important implications for both measuring and mitigating emissions, as I will expand upon in my following points.

Traditionally, EPA and other groups have estimated O&G methane emissions with inventory approaches such as emission factors and engineering equations that rely primarily on assumptions rather than

measurements. For example, an operator would estimate emissions from pneumatic pumps by multiplying their number of pumps by an emission factor that represents the average emission rate of their pumps. Emission factors typically are based on limited measurements collected at the component-level, such as by directly measuring the methane emitted from a leaky valve. Unfortunately, numerous studies have discovered that these traditional approaches tend to underestimate emissions, sometimes dramatically. Many of the challenges are due to skewed emission rates, such as not sampling enough sites to include the highest emitting sources, or being unable to accurately quantify very large emissions with component-level measurements. In contrast, newer approaches estimate emissions from empirical data based on measurements collected at larger spatial scales such as by site or basin. One example is an EPA-developed approach that parks a vehicle downwind of a site to calculate total, site-level emissions from the concentration and wind data.[11,12] Another example is flying an aircraft upwind and downwind of an area to calculate regional emissions with the mass balance approach.[13] Compared to traditional approaches, these empirical methods are more accurate for estimating total emissions since they can better account for high emitting sources. Therefore, Alvarez et al (2018) estimated national emissions based primarily on site-level measurement data from over 400 well pads in 6 basins; these estimates were validated by comparing to independent, aircraft-based, regional emission estimates from 9 basins. I want to clarify that traditional approaches including component-level measurements remain valuable because they provide data about which types of equipment are responsible for emissions, but relying on these approaches to estimate total emissions causes EPA and others to underestimate the magnitude of the problem.

The third common finding in O&G methane research is that almost all emissions are avoidable. Skewed emission rates not only means that a relatively small number of sites have very high emissions, but also that most sites have low emissions. This is critical because it indicates that low emissions are the normal state while high emissions are anomalous. There are several cost-effective options for mitigating emissions depending on their source and cause.[14] One option is replacing equipment that vents intentionally, such as pneumatic controllers, with low-bleed or zero-bleed alternatives. Frequent inspection is key for large, unintentional sources so they can be rapidly detected and repaired. In many cases, emissions are caused by a simple issue that can be fixed immediately, such as a tightening a leaky valve. Other sources may require more extensive operational or engineering changes to minimize their chance of recurrence, but in many cases these actions will be cost-effective and result in greater operational efficiency in addition to lower emissions. For example, a controlled oil storage tank that is repeatedly leaking out its hatch may have an undersized vapor recovery unit (VRU); upgrading the VRU would reduce emissions and capture more gas to market.[15] Through a combination of regular inspection and root cause analysis, operators can identify the highest emitting sources, determine the underlying issues responsible for emissions, and make the changes necessary to bring all their sites to a normal, low emissions state.

How can we reduce oil and gas methane emissions?

Our scientific understanding of O&G methane emissions has advanced greatly in the last decade. We now know that total emissions are even higher than previously thought but many sites operate with low emissions. While there have been important strides made to reduce emissions in the United States including federal and state regulations, technological advancements, and corporate commitments, much work remains to both achieve further reductions and validate that reported reductions accurately reflect an actual decrease in emissions.

At the federal level, the U.S. had begun to make important steps regulating methane emissions and the waste of natural gas during the Obama administration, including the promulgation of a Bureau of Land Management Waste Prevention Rule for all O&G sources on federal and tribal lands and an EPA New Source Performance Standard for new and modified O&G sources nationwide. These rules had many important requirements that could greatly reduce emissions of methane and VOCs and waste of natural gas at regulated sites, such as semi-annual leak detection at well pads. Unfortunately, the Trump administration has decided to ignore the science and is working to weaken and repeal these rules. In a misguided attempt to place the short-term interests of a few O&G companies ahead of public health and environmental protection, the administration is harming the country and ultimately the O&G industry by failing to incentivize cost-effective solutions that will reduce environmental impact, improve operational efficiency, and drive further technological advancement. Although some leading O&G companies are voluntarily performing these actions, many are not, and therefore regulations are critical for moving the entire industry to implement solutions.

I urge the Committee members to push back against the Trump administration's flawed legal and scientific rationale for weakening and repealing federal O&G regulations for natural gas waste and emissions of methane and other air pollutants, particularly for federal and tribal lands.

Meanwhile, state, local, and tribal governments can serve as important allies for reducing emissions as several governments such as Colorado and New Mexico have implemented or are in the early stages of developing strong O&G regulations. As Colorado has shown since it became the first state in the nation to directly regulate methane emissions in 2014, strong state rules can have dramatic positive impacts on reducing methane emissions and waste from the O&G industry.

New Mexico and the Navajo Nation both have opportunities to develop and implement strong rules that will protect their citizens from air pollution and wasted energy resources. These regulations can and should require a comprehensive set of nationally leading controls that will greatly reduce this emission and waste problem, including requirements like frequent leak inspections, lower emitting equipment, reduced flaring, and pathways that allow for further technological development.

I will highlight two key components of effective regulations: 1) frequent leak detection and repair, and 2) an alternative compliance pathway for incorporating new technologies and work practices.

Frequent leak detection is critical for reducing emissions since a relatively small number of sources are responsible for the majority of emissions at any one time. Rapidly detecting and fixing the highest emitting sources can substantially reduce total emissions; conversely, failing to mitigate these sources means that total emissions can remain high even after implementing other solutions. The original New Source Performance Standard required semi-annual leak detection at well pads with optical gas imaging cameras. The proposed NSPS reconsideration would reduce the inspection frequency, but the science supports moving in the opposite direction of more frequent inspections – at least quarterly – such as is already required in parts of Wyoming and for certain sources in Colorado. And surveys can involve more than just looking for leaks – ideally, operators would perform a comprehensive site assessment that searches for both ongoing emissions and issues such as malfunctioning equipment or poor site design that could later trigger anomalous emissions.

As a consequence of both scientific advances in measuring O&G methane emissions and greater attention on the issue, there has been a concurrent expansion in applied technologies and methods for detecting, quantifying, and mitigating emissions. These innovative approaches include continuous stationary monitors and mobile sensors mounted on vehicles, drones, aircraft, and satellites for detecting emissions. Compared to optical gas imaging, these new methods tend to be lower cost, but with higher detection limits that only find the biggest sources. However, since the largest emitters are responsible for the majority of emissions, an approach that frequently detects and mitigates these sources can achieve equivalent or better emission reductions than infrequent detection of all sources. To facilitate continuous improvement and more cost-effective mitigation, regulations should include a performance-based pathway that allows O&G operators and technology developers to implement alternative technologies and work practices that achieve at least the same magnitude of total emission reductions as the default regulatory approach. The EPA New Source Performance Standard pathway for approving alternatives to optical gas imaging is a first step, but major improvements are needed to develop a clear, expedient, and scientifically-rigorous process. Critically, equivalency determinations should be based on a transparent, objective process that uses a combination of controlled testing and modeling to estimate emission reductions from implementation of a technology and work practice across a population of sites. EDF and Environmental Council of the States recently published a report summarizing our recommendations for an alternative compliance pathway.[16]

Conclusion

In summary, we have greatly increased our understanding of O&G methane emissions since EDF and others started research on this issue less than a decade ago. Methane emissions from the U.S. O&G supply chain are 13 million metric tons, 60% higher than EPA estimates, and these emissions almost double the short-term climate impact of burning natural gas for energy. In New Mexico, upstream O&G sites emit at least one million tons methane, enough waste to meet the natural gas needs of every home in the state. Research has shown that emissions are highly skewed with a relatively small number of sites contributing the majority of emissions at any one time, which means traditional methods tend to underestimate emissions, but also that low emissions are readily achievable. Strong regulations that are

based on science and include frequent leak detection and a pathway for innovative approaches are critical for reducing emissions. Everyone wins by reducing methane emissions: the planet experiences less warming, communities are exposed to less pollution, and O&G companies improve their efficiency and reduce waste of a valuable product. As both a scientist and concerned citizen, I am hopeful that these mutualistic solutions will be adopted widely as knowledge of their benefits spread. Thank you for the opportunity to speak on this important issue.

References

1. Etminan, M., Myhre, G., Highwood, E. J., & Shine, K. P. (2016). Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing. *Geophysical Research Letters*, *43*(24).
2. Howarth, R. W., Santoro, R., & Ingraffea, A. (2011). Methane and the greenhouse-gas footprint of natural gas from shale formations. *Climatic Change*, *106*(4), 679.
3. Alvarez, R. A., Pacala, S. W., Winebrake, J. J., Chameides, W. L., & Hamburg, S. P. (2012). Greater focus needed on methane leakage from natural gas infrastructure. *Proceedings of the National Academy of Sciences*, *109*(17), 6435-6440.
4. https://www.edf.org/climate/methane-research-series-16-studies
5. Alvarez, R. A., Zavala-Araiza, D., Lyon, D. R., Allen, D. T., Barkley, Z. R., Brandt, A. R., ... & Kort, E. A. (2018). Assessment of methane emissions from the US oil and gas supply chain. *Science*, *361*(6398), 186-188.
6. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
7. https://www.edf.org/energy/explore-new-mexicos-oil-and-gas-pollution
8. Brandt, A. R., Heath, G. A., & Cooley, D. (2016). Methane leaks from natural gas systems follow extreme distributions. *Environmental science & technology*, *50*(22), 12512-12520.
9. Omara, M., Zimmerman, N., Sullivan, M. R., Li, X., Ellis, A., Cesa, R., ... & Robinson, A. L. (2018). Methane emissions from natural gas production sites in the United States: Data synthesis and national estimate. *Environmental science & technology*, 52(21), 12915-12925.
10. Lyon, D. R., Alvarez, R. A., Zavala-Araiza, D., Brandt, A. R., Jackson, R. B., & Hamburg, S. P. (2016). Aerial surveys of elevated hydrocarbon emissions from oil and gas production sites. *Environmental science & technology*, *50*(9), 4877-4886.
11. https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NRMRL&dirEntryId=309632
12. Robertson, A. M., Edie, R., Snare, D., Soltis, J., Field, R. A., Burkhart, M. D., ... & Murphy, S. M. (2017). Variation in methane emission rates from well pads in four oil and gas basins with contrasting production volumes and compositions. *Environmental science & technology*, *51*(15), 8832-8840.
13. Karion, A., Sweeney, C., Kort, E. A., Shepson, P. B., Brewer, A., Cambaliza, M., ... & Herndon, S. C. (2015). Aircraft-based estimate of total methane emissions from the Barnett Shale region. *Environmental science & technology*, *49*(13), 8124-8131.
14. https://www.edf.org/icf-methane-cost-curve-report
15. https://www.epa.gov/sites/production/files/2015-09/documents/oilgascompliancealert.pdf
16. https://www.edf.org/sites/default/files/documents/EDFAlternativeComplianceReport_0.pdf