Detecting and Quantifying Methane Emissions from the Oil and Gas Sector

A Hearing of the
Committee on Science, Space, and Technology
United States House of Representatives

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The Testimony of
Gregory Rieker, Ph.D.
LongPath Technologies, Inc.

Chairwoman Johnson, Ranking Member Lucas, and distinguished Members of the Committee, thank you for inviting me to testify today. My name is Greg Rieker and I am a Co-founder and the Chief Technology Officer for LongPath Technologies, a spin out from the University of Colorado, where I am also an Associate Professor of Mechanical Engineering. My testimony is on behalf of LongPath Technologies.

"You can't improve what you don't measure." That is the topic of today's hearing and it has been the focus of my work for the past decade.

Emissions measurement helps us understand the nature and magnitude of oil and gas emissions, it helps us determine the best policy actions to pursue, and it helps us know whether mitigation efforts are making a difference. Along these lines, we've heard about the work of CarbonMapper, EDF, and NETL creating and interpreting data from satellites, airplanes, and field crews to generate large-scale emissions distribution information for decision and policy making. But there is an additional component that is also critical, and what I hope to bring to the conversation. It is that the action of emissions mitigation happens at the local level. So continuous, specific-facility monitoring with instantaneous feedback directly to the folks that are in charge of fixing the problem - the oil and gas companies themselves - is critical to close out the stack of necessary measurements.

That is what LongPath brings to the challenge. We've been called the "5G of methane"…a network of continuous monitoring that feeds back instantaneous emissions data to oil and gas companies 24/7 and alerts them of a leak as it is happening. This type of tool is the key to not only understand emissions, especially intermittent emissions, but also to reduce and maintain low emissions.

The technology behind the LongPath network is something akin to a methane radar. We use Nobel prize winning frequency comb lasers that emit hundreds of thousands of colors of infrared light. We quantify the level of methane and other greenhouse gasses by detecting how much of each color of that infrared light is absorbed while it is traveling through the atmosphere. The systems are tower-mounted, and each tower covers an area of 20 square miles, providing specific, quantitative emissions rate data on a well-by-well basis for customers within the purview of the towers. It is 10 to 1000 times more sensitive than aerial and satellite technologies, and quantifies emissions from specific facilities in the 20 square mile area many times each day and night. Critically, it sheds light on and enables capture of intermittent emissions, one of the most common forms of emissions. These types of emissions are difficult to catch and fix with survey methods like aircraft, satellite, and the current EPA-stipulated "Best System of Emissions Reduction" (or BSER), Optical Gas Imaging camera surveys by human crews or drones.

What is important to recognize is that LongPath, and the many other wonderful technologies that are being developed out there, is quite new. LongPath is an example of government support for technology development in action. This technology got its start under numerous government-funded university and national lab research programs. I started working with the frequency comb lasers that underpin LongPath in 2012 at NIST, the National Institute of Standards and Technology, where a lot of the early government funded work on this technology happened. I moved as a professor to the University of Colorado, and was funded in 2014 by ARPA-E, the Department of Energy's Advanced Research Projects Agency that I know many of you on this committee have played a heavy role in creating and maintaining. Our team transitioned this technology finally to a proven commercial product in 2020, and we now have systems out covering 360 square miles with 17 oil and gas companies as customers. We're on track to reach 1000 square miles this year. What is important from this story, aside from the example it gives of the American R&D machine in action, is that this, along with many other technologies, has reached the market just in the last few years.

The relative newness of these technologies means that there is a struggle on how they should be incorporated into policy-making, as well as a general lack of industry knowledge of their existence and capabilities.

I therefore hope there are three things that you will take away from my testimony today:

1. Powerful new technologies exist that can help us not just understand emissions, but give companies the kind of immediate feedback they need to control them, at a cost that is not prohibitive to oil and gas operations. The savings realized pay for themselves.
2. Please consider technology evolution in the policy making that this and other bodies are considering today. EPA Policies that stipulate a particular technology, or SEC rules that punt on measurement altogether and are based on counts of equipment and calculated emissions will set us back years in making American oil and gas the crown jewel of low-

emissions production worldwide. We have provided a detailed work practice and framework for the inclusion of LongPath and other forms of continuous, quantitative monitoring to the EPA as an alternative means of compliance, and I hope this component will enter the upcoming rule. As you write policy, plan for quantification, as you want to build a future where regulations are based on meaningful metrics and performance-based.

3. I urge you to think about the role government might play in methane emissions abatement as a public good and public infrastructure… just like a road or bridge or internet connectivity. Could we competitively bid an infrastructure project, much like a road or bridge, for companies to build a multi-technology network of monitoring to oil and gas operators? Making it cost effective for them to get the data they need to have clean operations. For example, LongPath in collaboration with other methane data providers, can cover the Permian, one of our largest oil and gas basins, with the infrastructure for 24/7 monitoring for less than the cost of the last James Bond movie. That's less than the cost of 20-30 miles of interstate highway.

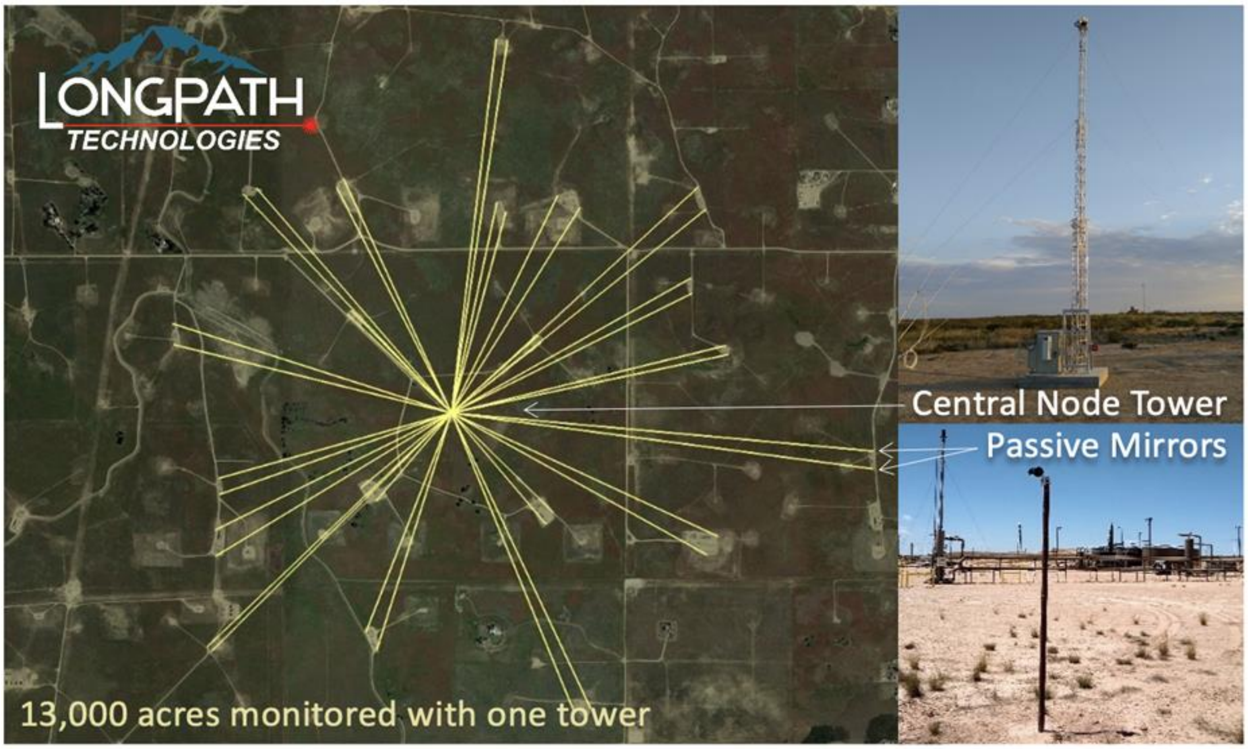
Thank you for the opportunity to be here, and I look forward to further discussion.

Summary information on LongPath Technologies

The LongPath system is a fixed location continuous monitoring system. The LongPath monitoring system employs dual frequency comb spectrometer (DCS) technology with a detection range of up to 5 km. The LongPath system is capable of continuously monitoring multiple facilities via a single installation of a centralized tower from which the laser light source is generated. The high site coverage of a single reading, combined with high frequency of data collection and low detection threshold, classify this technology as "true continuous". The LongPath system employs a rigorous system of quality control checks to ensure incoming data is valid. With this data, the LongPath system is capable of accurately quantifying emission rates with a detection and quantification level of 0.2 kg/hr. Time-to-detect of emission from leak start to leak detection for sustained emissions ranges from several minutes to less than one day.

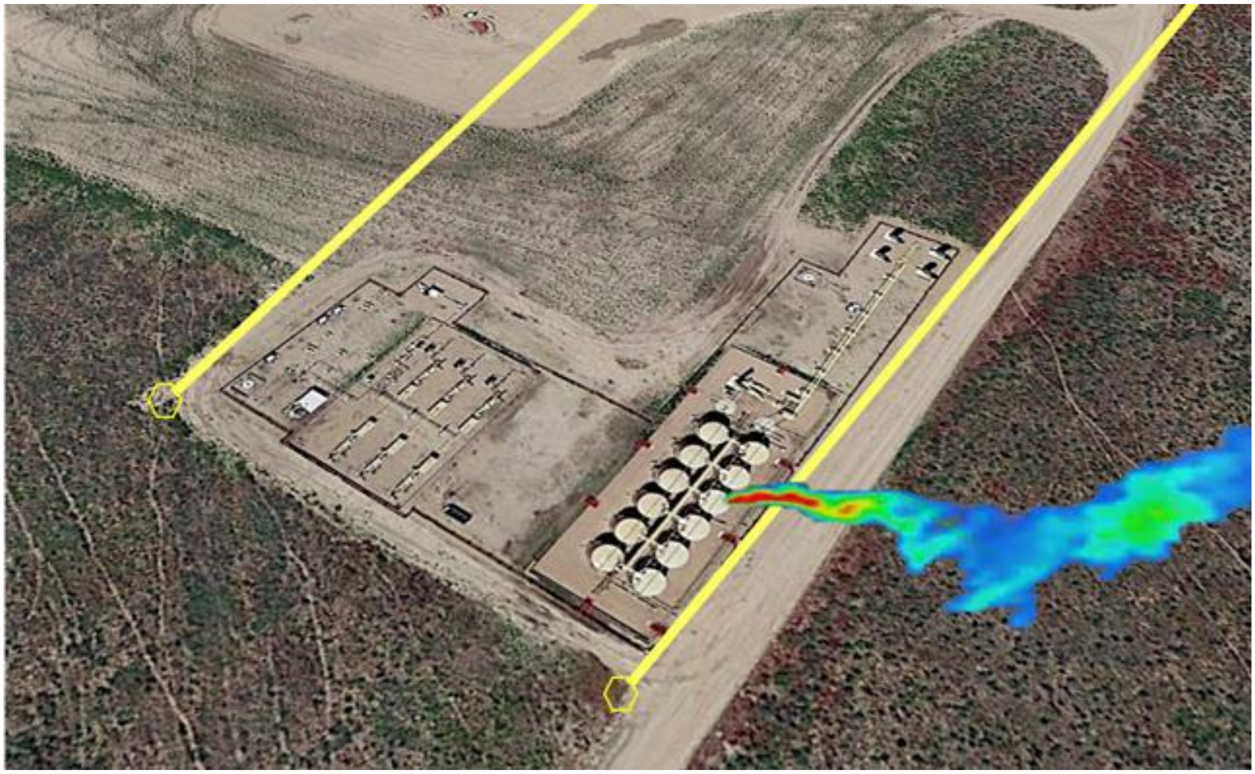
LongPath's DCS technology was developed at the National Institute of Standards and Technology (NIST) and the University of Colorado Boulder and was transitioned for field use and oil and gas monitoring by LongPath's founders at the University of Colorado under the Department of Energy's ARPA-E MONITOR program. Open-path, laser-based DCS measurements rely on frequency combs, a specialized class of lasers that output hundreds of thousands of stable, discrete wavelength elements or "comb teeth"; an innovation that garnered the Nobel Prize at the University of Colorado in 2005. DCS leverages these properties to enable spectroscopic measurements at an unprecedented combination of spectral bandwidth (>100 nm), resolution ($<2x10^{-3}$ nm) and signal-to-noise ratio, providing precise and accurate absorption spectra that yield high-fidelity, multi-species measurements.[1]

The LongPath system is composed of a 50-foot-tall retractable tower on an approximately 8-foot square base, where a field hardened control cabinet houses LongPath's proprietary laser spectrometer and computing and control systems. A telescope, which emits the laser light and receives (detects) the reflected, return laser light, sits at the top of the tower. The control cabinet, tower, and an anemometer are all co-located at what is referred to as the central node. Lastly, retroreflectors are installed on and/or around each monitored area and return emitted laser light to the transceiver.



LongPath System deployment overview. A central node is shown in the center of the starburst pattern in the left-hand panel. In that panel, yellow lines indicate the geometry of eye-safe and invisible laser light that travels between the telescope (located at the central node location) and retroreflective mirrors (or "passive mirrors") located in and around monitored areas.

Measurements are coupled to an atmospheric model and methane source sizing/localization inversion framework.[2,3] LongPath positions laser beams to create a fenceline around each monitored area and measures plumes as they cross the beamline. The sensor geometry for LongPath is not a single point in space, but, instead, an integrated line (pathway) through space between the telescope head and the retroreflective mirror (and back). LongPath's full fenceline attribute results in high spatial coverage of the monitored area with each reading that is taken under a wide range of wind directions.



Laser beam paths (yellow lines) extend between the telescope (outside image top) to retroreflector locations (yellow hexagons), providing a fenceline bounding the monitored area. Sites are measured during wind conditions that favor high site coverage (potential plumes would cross bounding laser beams). A theoretical plume is shown emitting from the tanks and crossing the downwind beam.

With this system, LongPath has demonstrated in single-blind testing and field testing the ability to detect, locate, and size methane sources from individual facilities down to flow rates less than 0.2 kg/hr over large regions.[4]

[1] Rieker, G., et al., (2014). Frequency Comb-Based Remote Sensing of Greenhouse Gases over Kilometer Air Paths, Optica, 1, 290-298. https://doi.org/10.1364/OPTICA.1.000290

[2] Coburn, S., Alden, C. B., Wright, et al., (2018). Regional trace-gas source attribution using a field-deployed dual frequency comb spectrometer. Optica, 5(4), 320. https://doi.org/10.1364/OPTICA.5.000320

[3] Alden, C. B., Ghosh, S., Coburn, S., et al. (2018). Bootstrap inversion technique for atmospheric trace gas source detection and quantification using long open-path laser measurements. Atmospheric Measurement Techniques, 11(3), 1565–1582. https://doi.org/10.5194/amt-11-1565-2018

[4] Alden, C. B., Coburn, S., Wright, R. J., et al. (2019). Single-blind quantification of natural gas leaks from 1 km distance using frequency combs. Environmental Science & Technology, 53(5), 2908–2917. https://doi.org/10.1021/acs.est.8b06259

Importance of Continuous Monitoring

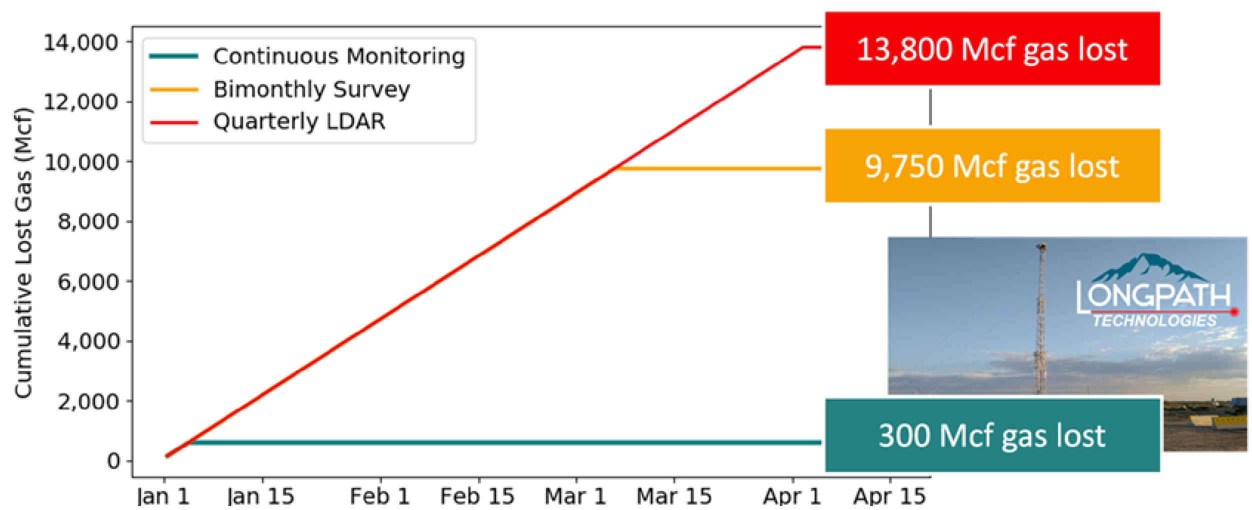
The benefits of continuous monitoring are many and impact many stakeholders: neighboring communities in oil and gas production areas, the environment and global communities grappling with a changing climate, and an industry that is working to reduce waste and cut emissions.

Methane emissions from oil and gas are intermittent and vary through time, at both producing and abandoned well sites[1],[2], with intermittent emissions contributing substantially to overall emissions. Continuous monitoring is therefore unparalleled in the value it provides. Snapshot monitoring approaches (OGI, aircraft, satellite surveys) can't provide adequate information for operators to mitigate, or often even detect, intermittent emissions. Continuous monitors can mitigate intermittent emissions by revealing temporal context about deviations from baseline rates, which can be linked with SCADA data for root cause analysis. Off-site diagnosis and even repair can often be accomplished. Further, continuous monitors don't mistake intermittent emissions for persistent emissions, as can be the case for snapshot-in-time surveys (resulting in wasted OGI follow-ups).

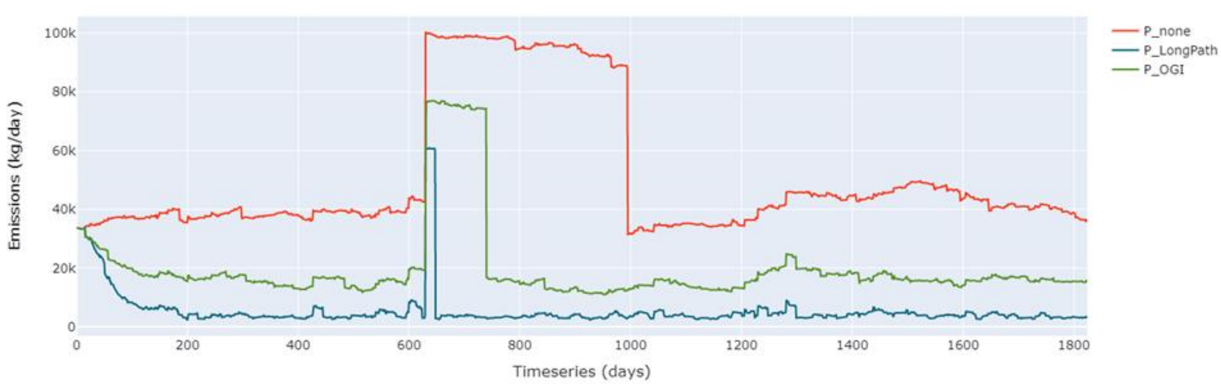
The temporal context and coverage provided by continuous monitors also means that leak repairs can be immediately verified without site visits or OGI surveys. LongPath has found linked leaks that it took more than one attempt to repair – without continuous monitoring, the first repair would not have mitigated all emissions, and the operator wouldn't have known that other problems persisted despite OGI follow-up

Continuous monitoring is highly scalable. With modest capital investment, around 1000 LongPath sensors could provide cost-effective continuous monitoring for most of the Permian Basin of West Texas and Southeastern New Mexico. Already, LongPath is continuously monitoring more than 230,000 acres in the DJ, Anadarko, Delaware and Midland basins. Once LongPath's networked infrastructure is in place, any site in the area can be quickly and cost-effectively subscribed. This includes orphaned wells, which LongPath can monitor, quantify and prioritize for plugging.

Finally, and most importantly, continuous monitoring affords rapid repair, such that cumulative emissions to the atmosphere are tens to hundreds of times lower than survey approaches can provide. The figure below is based on a real leak mitigated by LongPath; a stuck dump valve that was repaired in 2 days, resulting in a cumulative loss to the atmosphere of 300 Mcf. A bi-monthly or quarterly survey might not have discovered the leak for 2-3 months, which would have resulted in some 30-50 times higher cumulative emissions emitted to the atmosphere. The difference in gas lost between continuous monitoring and a theoretical quarterly survey would have been 13,500 Mcf, or roughly 10.4 t. At a (currently below-market) value of $3.25 / Mcf, a loss of 13,800 Mcf is roughly $44,850 over 3 months. These losses dwarf the cost of the monitoring itself (and for many years) – a clear proof point that continuous monitoring is cost effective. The social cost of methane ($1,800/t) would equate to $18,720 saved compared with quarterly LDAR.



The below LDAR-Sim model results[3] show expected emissions given a LongPath emissions mitigation program ("P_LongPath", blue), a quarterly LDAR program ("P_OGI", green, with efficacy matching Zimmerle et al.[4]) and no LDAR program ("P_none", red). Interestingly, in this simulation, a super-emitter event occurs just following an OGI visit. While this would seem to be a rare event, LongPath has documented occurrences of this scenario in customer monitoring. In periods of both normal operations and during a fugitive event, LongPath's overall emissions reductions are substantially better than quarterly OGI.



[1] Johnson and Heltzel, "On the Long-Term Temporal Variations in Methane Emissions from an Unconventional Natural Gas Well Site."

[2] Riddick et al., "Variability Observed over Time in Methane Emissions from Abandoned Oil and Gas Wells."

[3] Highwood Emissions Management, January 2022.

[4] Zimmerle et al., "Detection Limits of Optical Gas Imaging for Natural Gas Leak Detection in Realistic Controlled Conditions."

EPA and continuous monitoring as an alternative means of compliance

LongPath has provided to EPA a detailed and complete work practice and framework for the inclusion of LongPath and other forms of continuous monitoring in the EPA's rule as an alternative means of compliance.

Separately, we are providing to EPA, together with a diverse group of stakeholders, including industry, NGOs and legal experts, a matrix table for compliance under different frequencies and detection thresholds that is entirely technology-neutral, paving the way for regulations that will not hinder either current or future technological innovations.

Accompanying each method (technology) used to meet a given portion of the matrix table will be: 1) technology-specific work practices, 2) details of method certification, and 3) response requirements for when emissions exceed stated thresholds.

Elements of a framework provided to EPA by LongPath

LongPath provided written response to all questions posed by EPA in the draft language published in November. These questions formed the EPA's pathway for inclusion of continuous monitoring as a compliance method in the final rule.

In addition to providing answers to the EPA's prompts, LongPath also outlined a specific framework for monitoring and response requirements that suit the LongPath technology class. No other technologies operate in the same way as LongPath, so we currently stand as the only C-Open Path (Continuous-Open Path) technology type in our class. Nonetheless, it is incumbent upon EPA to create rules open to all technology classes, regardless of how unique, and the offered matrix approach and generalized frameworks provide this ability.

Despite the work practice and response requirements being specific to the C-Open Path technology class, the bulk of the framework is generalizable to include all continuous monitoring platforms and the unique challenges posed by and solvable by continuous tech (e.g., the ability to characterize intermittent emissions and offer alternate response requirements than for persistent emissions).

Next Steps: R&D efforts needed to enable the EPA's proposed regulations

Formation of a neutral third party organization that must: 1) set standards for testing of emissions detection work practices, 2) provide auditing of and testing of technologies with stated work practices, and 3) provide a clearing house for certification and reports.

The DOE and other federal institutions will be ideal venues for these efforts to be initiated and/or carried forward. Existing and new R&D dollars should be considered for use in the development of the standards, certification practices and clearinghouse for approved technologies.