Comment Letter re: Reducing Methane Emissions from Canada's Oil and Gas Sector – Discussion Paper

Introduction

Bridger Photonics, Inc. ("Bridger") appreciates the opportunity to provide comments on Environment and Climate Change Canada's (ECCC) Discussion Paper: Reducing Methane Emissions from Canada's Oil and Gas Sector ("Discussion Paper"). Bridger is a technical and market leader in the detection, localization, and quantification of methane emissions. Bridger commercialized its aerial light detection and ranging (LiDAR) technology for methane detection, Gas Mapping LiDAR™ (GML), in 2019 as a data product offering, which has been rapidly and broadly adopted by the oil and gas industry in North America over the past three years.

Bridger's ability to confidently detect over 90% of typical production basin emissions places us in a unique position to clearly assess and project the impact that emission rate detection sensitivity will have on emissions reduction. We leverage aggregate data measured across the major North American production basins as a foundation for our comments on the questions posed in Annex 1 of the ECCC Discussion Paper and to "help inform the development of new federal regulations and other measures needed to achieve at least a 75% reduction in methane emissions from the oil and gas sector from 2012 levels by 2030."

We recently commented on the United States (U.S) Environmental Protection Agency's (EPA) proposed rule regarding methane emissions from the oil and gas industry: "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review" (86 Federal Register 63110),[1] hereafter referred to as "Proposed Rule." Many of the topics on which the EPA solicited feedback are related to the discussion questions posed in the ECCC Discussion Paper. Bridger's full comment letter to the EPA is available here.

Bridger's comments below are organized in the order of the questions posed in Annex 1 of the Discussion Paper.

1. What opportunities exist for regulatory cooperation and alignment, domestically and abroad?

We support the unified alignment of federal and provincial regulations across Canada to the extent practicable, especially concerning the acceptability and approval of technologies for methane detection. We also support similar alignment and cooperation between the U.S. and Canada. Bridger urges cooperation and alignment with regards to required methane emission rate detection sensitivity, requiring an associated probability of detection (PoD), the acceptance of alternative detection solutions, and monitoring frequency requirements (e.g. quarterly vs. bi-monthly).

Alignment within Canada as well as between the U.S. and Canada would streamline regulatory compliance for both solution providers and operators, especially those who have infrastructure in both countries.

2. What lessons from Federal and Provincial regulatory development and Equivalency experiences should be considered?

As discussed in Question 1, we advocate for unified alignment between provincial and federal regulations, as well as among U.S. and Canadian regulations to simplify the process for all.

We believe that basin-wide or federal approval for alternative emissions detection is ideal. Applying to the Alternative Fugitive Emissions Management Program (Alt-FEMP) on an operator-by-operator basis is inefficient and burdensome for both the operators and the alternative solution providers and is a barrier for operators seeking to use alternative methods to further reduce their emissions. We advocate for broad-scale approval of solution providers at the provincial and/or federal level if the solution has been rigorously validated, including auditing of aggregate emissions detection (assessment of a large dataset of actual field detections, not just a single evaluation) at the basin level. More detail on aggregate emissions detection evaluation (the "Aggregate Emissions Distribution Test") is discussed in Question 7.

3. What best practices or lessons from international jurisdictions should be considered?

As described in Question 2, we believe that a larger basin-wide, provincial-wide, or federal regulatory approval of alternative emissions monitoring technologies streamlines emissions detection (and therefore reduction) for an operator by reducing the barrier to implementing a new technology, compared to requiring each operator to submit an individual Alt-FEMP application.

Regardless of the scale of regulatory approval for a given technology, there are critical elements of performance reporting. First, an emission rate detection sensitivity by itself (such as "10 kg/hr") is insufficient. A probability of detection and conditions under which the performance is expected to be achieved (e.g. "typical" or "all" conditions) are also needed. A single detection sensitivity value, such as 10 kg/hr, could be interpreted to mean a technology must detect all emissions greater than 10 kg/hr, or that a technology must have once detected an emission of this size under ideal or laboratory conditions. The emissions detection and reduction resulting from these two interpretations would be orders of magnitude different.

Lacking the appropriate performance metrics, there's no way to assess whether a detection sensitivity of 10 kg/hr will achieve 75% emissions reduction. To solve this problem, in addition to the value for detection sensitivity, the standard must include (1) a required probability of detection, and (2) a specification of conditions under which the alternative work practice must achieve this metric. Each of these requirements is further described below:

(1) Probability of Detection. Emissions detection is statistical and probabilistic in nature. This means that a technology might detect a leak of a given size (e.g. 10 kg/hr) one time and miss a leak of the same size the next time (or the next thousand times!). The problem is, lacking anything more than the statement that a technology can detect a certain emission rate detection sensitivity, there's no way to know how likely it is that the technology would detect a leak of that size, and therefore no way to assess the emissions reduction potential of the technology. To enable such assessment, one needs to know whether leaks of that size were detected with high confidence (e.g. >90% probability of detection), detected half of the time (50% probability of detection), or with a negligible likelihood (e.g. <1% probability of detection). The probability of detection could fall anywhere in the range of <1% up to 100%. To remove this ambiguity, we urge the ECCC to require the detection sensitivity value to be coupled with a probability of detection (e.g. 10 kg/hr with a required >50% probability of detection).

(2) Conditions Under Which Performance is Achieved. In addition to the probabilistic nature of detections under a given set of conditions, different operational and environmental conditions significantly impact the probability of detection. No matter the detection technology, there will be conditions under which the technology performs better or performs worse. Operational parameters are often within an aerial technology solution provider's control (e.g. flight altitude, flight speed, etc.). Conversely, many factors that can affect the detection sensitivity are often outside of the solution provider's control (e.g. ground wind speed, the reflectivity of the ground surface, cloud cover, etc.). The problem is that emissions reduction outcomes can be vastly different when the reported detection sensitivity is achieved under "typical" or "all" conditions, versus under "ideal" conditions that don't represent the actual application of the work practice. To remove this ambiguity, and in addition to requiring a probability of detection along with the stated detection sensitivity value, we urge the ECCC to require that the specified detection sensitivity be achieved under "typical" conditions for which the alternative work practice is applied. If a technology cannot meet the detection sensitivity metric with, for example, high winds, wet ground, or cloud cover, then the technology must not be used to satisfy the regulations under those conditions. Bridger suggests a simple and objective auditing mechanism to ensure the detection sensitivity metric is achieved under typical conditions. This is described in our response to Question 7.

It is imperative that aerial detection technologies perform to the required standard during the actual application of the work practice, not merely in "ideal" conditions of a controlled release (e.g. known emitter location, controlled calibration parameters, no ramifications of false positives, favorable sunlight and cloud conditions, etc.). The difference between 50% probability of detection and <1% probability of detection, and between "typical" and "ideal" conditions can result in orders of magnitude differences in emissions reduction.

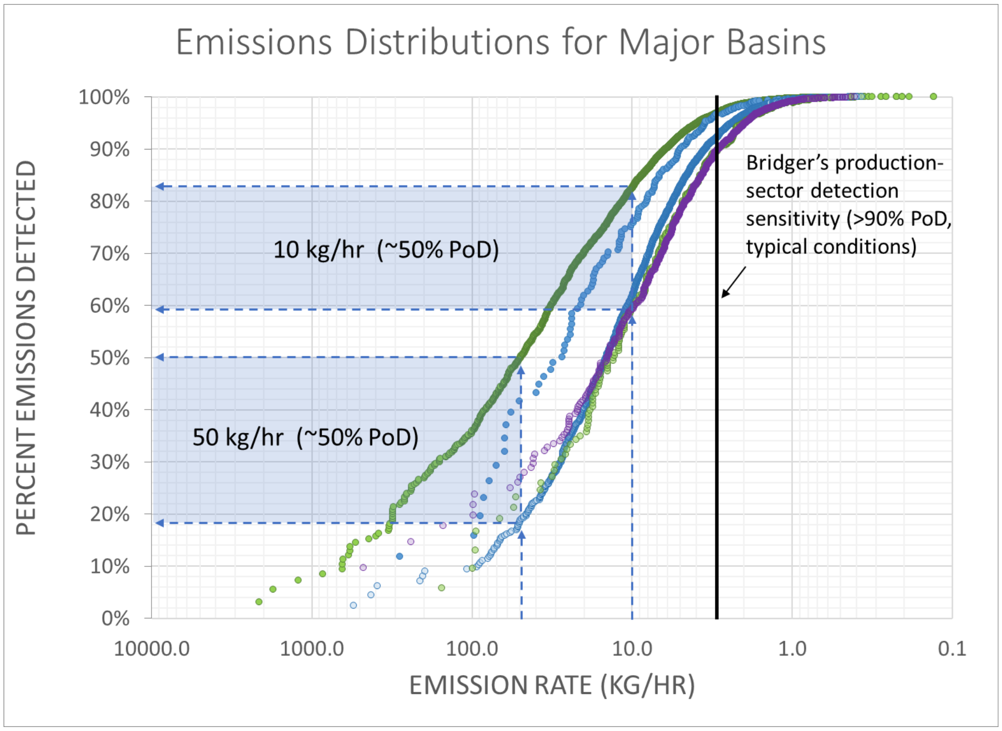

Figure 1. Emissions distributions for five major oil and gas basins in North America: Alberta,[2] Anadarko, Bakken, Denver-Julesburg, and Permian *(in no particular order on the plot)*. The shaded regions show the percentage of emissions detected for detection sensitivity of 10 kg/hr with ~50% PoD (59% to 82%) and 50 kg/hr with ~50% PoD (18% to 50%), depending on the basin.

Figure 1 shows emissions distributions for over 12,000 production facilities in five major North American oil and gas basins measured by Bridger's aerial LiDAR technology. The emissions distributions are displayed as measured at the source level (Gas Mapping LiDAR achieves equipment-level spatial resolution). The distributions are not aggregated to the site level for the cases when there are multiple emission sources on a single site, and the distributions include both fugitive and normal operating process emissions (NOPEs). This plot can be used to determine the detection sensitivity required to detect a given percentage of Bridger's detected emissions in each basin. First, note that Bridger's emission rate detection sensitivity for the production sector is 3 kg/hr (>90% probability of detection under typical conditions), which is represented by the black vertical line in Figure 1.[3,4] There is high confidence in Bridger detecting emission sources with rates greater than this threshold (data points to the left of the black line in Figure 1). For lower emission rates (to the right of the black line in Figure 1), the probability of detection decreases, and the asymptotic "roll-off" behavior displayed by each distribution is a result of this decreased probability of detection convolved with the decreased aggregate emissions from the smaller emissions sources (i.e. the actual emissions distribution). Note also that Bridger still detects emission events more than an order of magnitude below the stated detection sensitivity (nearly as low as 0.1 kg/hr), but such "lucky" detections should not be the benchmark by which detection sensitivity is defined. The probability of these detection events diminishes as the emissions become smaller. Again, this highlights the critical importance of including a probability of detection, and the conditions under which it is valid, along with an emission rate detection sensitivity value.

In the high-confidence region of emission rates to the left of the vertical black line, the emissions distributions of Figure 1 reliably map the percentage of emissions that would have been detected if other detection sensitivity with equipment-level spatial resolution would have been used instead of Bridger's technology. A 10 kg/hr step-function detection sensitivity threshold, which gives approximately equivalent results as 50% probability of detection, would have resulted in detection of between 59% and 83% of the emissions detected by Bridger, depending on the basin. This is roughly consistent with reducing methane emissions by 75% compared to current levels.

Figure 1 also highlights the negative impact of using poorer detection sensitivity. If a detection sensitivity of 50 kg/hr (~50% probability of detection) is used, only between 18% and 50% of the emissions detected by Bridger would be detected (i.e. 50% to 82% of emissions would be *undetected*), depending on the basin. It's important to understand that the undetected percentage of emissions will never be detected by a technology with this detection sensitivity, no matter how many times the sites are flown/scanned. To "lock in" more than half of existing emissions would be devastating to the environment and counter to Canada's emission reduction goals.

Bridger urges ECCC to incorporate an emission rate detection sensitivity in addition to a probability of detection (e.g. >50% or >90%) in which performance is met under typical conditions when considering what emission detection methods are acceptable or approved for use in their jurisdiction to meet methane reduction goals. An adequate scan frequency must also be incorporated to reach the goal of 75% emissions reduction (see Question 4).

4. Should Canada retain the approach in its current oil and gas methane regulations, and expand their coverage and increase their stringency?

Methane emission monitoring and reduction regulations require a certain yearly scan frequency in both the U.S. and in Canada. To predict the efficacy of using different scan frequencies for emissions detection, significant theoretical modeling has been performed, yet the model predictions vary widely depending on input parameters and assumptions. Bridger's position is that insufficient temporal data (on scan frequency) exists to validate those models or to confidently guide or inform policy. Standard OGI scans do not capture all leaks, regardless of how many times per year they are conducted, and alternative technologies with more comprehensive detection capabilities should be incorporated into the regulations to improve methane detection and reduction.

Lacking experimental data on the percent of emissions detected as a function of scan frequency, Bridger recommends using the U.S. EPA's modeled estimates for the percent of emissions reduction as a function of the number of scans per year, which is shown in Figure 2. The EPA estimates that four scans per year using their traditional Optical Gas Imaging scanning program would achieve 80% emissions reduction. Based on these modeled estimates, Bridger recommends that Canada require at least four scans per year to meet the 75% emissions reduction goals, but more may be needed depending on the probability of detection of the selected detection method. If future reliable experimental data disproves the EPA's modeled estimates, then Bridger recommends adjusting the scan frequency requirements accordingly to ensure >75% emissions reduction.

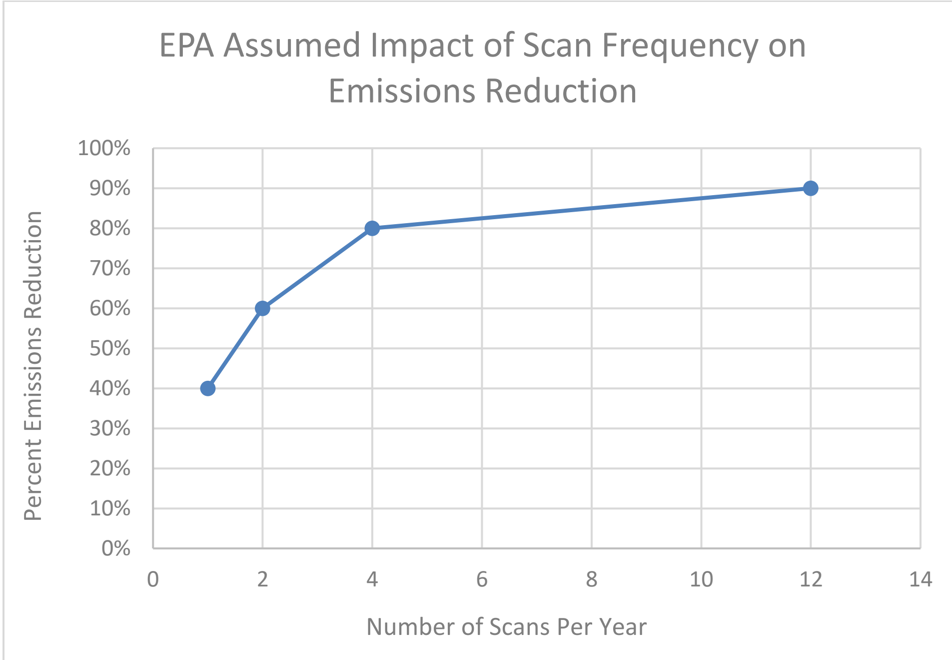

Figure 2. U.S. EPA's assumed impact of emissions reduction relative to the number of emission detection scans per year using their traditional Optical Gas Imaging scanning program. This plot was created by Bridger Photonics, Inc. using EPA data.

For a comprehensive emissions reduction estimate, the emissions reduction based on scan frequency *and* the probability of detection must be combined. For example, if a technology is used where the emission rate detection sensitivity is such that 90% of emissions are captured during a given scan, and monthly scans are used, this 90% probability of detection must be multiplied by the 90% reduction factor (i.e. 90% reduction corresponding to 12 scans per year, based on EPA's estimates in Figure 2), and would result in an estimated 81% emissions reduction.

5. Should Canada develop new, performance-based regulations?

Bridger supports performance-based regulations that achieve 75% emissions reduction. These must include an adequate probability of detection and an adequate scan frequency that ensures reduction goals are met (see Question 4). These performance-based metrics can apply to any technology, so operators have a choice of solutions for emissions detection (among those that are considered acceptable and verified—see Question 7 for a description of the Aggregate Emissions Distribution Test to verify performance).

6. Are there some sources of methane emissions that are not well suited to a performance-based requirement?

Normal Operating Process Emissions (NOPEs) are not well suited to performance-based regulations. A reasonable fraction of detected emissions is associated with Normal Operating Process Emissions (NOPEs) (e.g. a pneumatic valve) rather than fugitive emissions, and therefore no repair action is required because of the detection. While the NOPE components may be phased out by an operator over time and replaced with non-emitting components, these should be considered additional voluntary reductions that are not part of a performance-based requirement. Many of our clients use our identification and reporting of NOPEs to schedule and prioritize replacements and retrofits of the subject components to eliminate these emissions sources in addition to eliminating emissions that are tied directly to performance-based regulations. We therefore discourage the ECCC from implementing regulations or policies that would disincentivize the identification or reporting of NOPEs.

7. What monitoring and reporting requirements should support performance-based requirements?

As described above, Bridger supports the inclusion of an emission rate detection sensitivity metric, probability of detection, and operational conditions under which the metric is achieved as essential elements for an acceptable performance-based monitoring program. Additionally, agencies, operators, and third parties need assurance that the intended sites were actually scanned by the aerial technology and that the scans met the detection sensitivity performance metric from a statistical standpoint.

First, we therefore urge the ECCC to require reporting of an auditable scan swath with GPS ground coordinates that document the actual coverage area of the aerial scan. The GPS coordinates of the aircraft alone are insufficient because, for instance, the aircraft altitude impacts the scan swath width, and the aircraft "roll" impacts the lateral projection of the scan swath onto the ground. An accurate, geo-registered scan swath coverage, when combined with geo-registered gas plume concentration imagery, date-stamps, time-stamps, and detection sensitivity verification (see below) can also automate the auditing process.

In addition to the documented scan swath to verify that valid data was acquired from the sites, we urge the ECCC to require that aggregate emissions data from each aerial scanning solution provider pass a simple and objective audit to prove that the detection sensitivity performance metric is achieved by the technology (a) prior to the approval of the technology as an approved work practice, and (b) periodically during application of the work practice.

To ensure a technology achieves the emission rate detection sensitivity under actual operational conditions, the subject method requires the successful completion of an Aggregate Emissions Distribution Test. This test uses aggregate past measurements as an objective indicator that the technology continues to achieve the stated emission rate detection sensitivity. The Aggregate Emissions Distribution Test utilizes the fact that the statistical number of emission sources existing increases with decreasing emission rate. So, if the number of emission sources measured decreases with decreasing emission rate, that indicates undetected emission sources. Often, the number of emission sources as a function of emission rate is well described by a power law, Pareto distribution, or other probability density function.

To perform the Aggregate Emissions Distribution Test, the number of emission sources and the emission rate of all detected emission sources for all scans performed by the technology under the protocol over the twelve months prior to the month before the scan of the subject target area, are aggregated. From this aggregated data, the number of emission sources is plotted as a function of emission rate, as shown in Figure 3. The data set is fit using a polynomial to smooth the effect of random fluctuations in individual data points (green line in the figure).

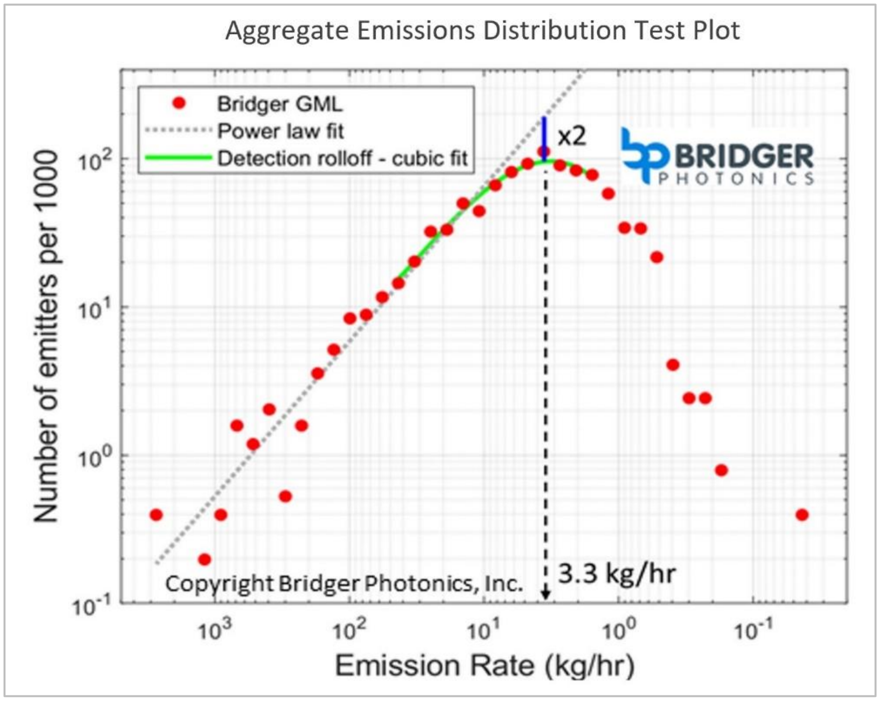

Figure 3. Actual Bridger Photonics' data of the number of emission sources (emitters, per 1,000), plotted as a function of emission rate. To the left of the vertical dotted line (3.3 kg/hr) are emitters that GML detects with 90% probability of detection, and to the right, the distribution drops off as the probability of detection decreases with decreasing emission rate. This aggregate emissions test can be applied to other technology with an adequate emission scan sample size.

To successfully complete the Aggregate Emissions Distribution Test, the emission rate at which the slope of the fit turns negative must be less than the emission rate detection sensitivity.

This solution offers many advantages. First, it is simple to implement and maintain by the ECCC. All that is required is a file with the anonymous aggregated emission source detections for each aerial solution provider in the alternative program (i.e. that data in Figure 1). Evaluating both the detection sensitivity and the spatial coverage auditing can be fully automated. The solution provides an even playing field for all technologies, and ensures, in the aggregate, that the detection sensitivity metric is achieved under the conditions under which the work practice is applied (as opposed to merely "ideal" conditions). The metric for success is objectively based on measured probability density functions.

8. What barriers exist related to methane monitoring? How can they be overcome?

Variable environmental conditions can affect the performance of the methane monitoring technology. Performance in a controlled release setting may not be indicative of performance in the field, therefore controlled release experiments alone should not be the basis on which a technology's performance is measured. After the technology is used in the field, evaluation of aggregate data (see Question 7) is needed to assess actual field performance using a large sample size or, effectively, a large experiment. The conditions during use in the field should also be disclosed.

9. How can real-time measurement technologies be incorporated into the regulations?

While continuous monitoring technologies are marketed to provide immediate alerts of emissions, there are considerations about their capabilities that need to be accounted for when creating regulations that involve them.

First, point sensor continuous monitoring technology solutions have systematic error sources that need to be considered and appropriately addressed under a regulatory framework. One of these includes false negative detections (i.e. missed leaks) for emissions emanating from higher altitudes. These emissions can include those from flares, storage tanks, or even compressor exhaust, and can occur regardless of the leak size. The leaks are missed because the point sensors are closer to the ground and the buoyancy of methane in air causes it to rise, never reaching the lower point sensors. More generally, spatial gaps for continuous real-time monitoring technologies present systematic errors in emissions measurements.

Second, even when point sensors do detect emissions, it takes time before they can provide actionable information. The wind must blow the emissions to multiple sensors and the sensors must gain confidence in a true positive detection over time.

Third, point sensors can struggle to accurately locate emissions spatially, particularly in cases with multiple emission sources, which degrades their ability to attribute emissions to particular equipment and correctly inform repair.

Fourth, the success of point sensor solutions can depend heavily on the number of sensors, their locations, and emission concentration detection sensitivity.

Fifth, some point sensor solutions have been known to degrade over time and the performance has been shown to degrade with environmental conditions such as humidity and temperature.

All of these factors should be considered during the rulemaking process.

10. Should the regulations allow a facility to select which regime to be subject to?

Bridger supports performance-based regulations in which operators have a choice of solutions for emissions detection (among those that are considered acceptable and verified for supporting a specific emissions outcome—see Question 7 for performance verification) so long as the solution can achieve (statistically) 75% emissions reduction. Acceptable solutions must include specific emission rate detection sensitivity and probability of detection requirements, as described in Question 3, and as required by the regulatory agency.

11. Should it allow this for different methane sources or only on a facility-wide basis?

Methane regulations should require differentiation of methane emissions sources to the equipment level. We find multiple emitters on many sites that we scan. Site-level emissions detection cannot distinguish these, and operators naturally repair the first one they find, leaving the other, potentially larger leaks, to continue emitting.

12. How should methane be treated in other oil and gas policies?

a. Carbon pricing

Not applicable to Bridger Photonics, Inc.

b. The oil and gas sector emissions cap (in development)

For 75% emissions reduction or an emissions cap for the oil and gas sector, please see our responses to Questions 3 and 4, for more information on how scan frequency and emission rate detection sensitivity must both be utilized to ensure the desired reduction outcome is achieved.

13. From the perspective of achieving net-zero GHG emissions by 2050, should any reductions for methane emissions be considered "dead ends" and avoided in the regulations?

Not applicable to Bridger Photonics, Inc.

14. What activities should the science and research community prioritize to support methane reduction?

The science and research community should prioritize continued assessment of the capabilities of various alternative technologies for emissions detection and reduction, including their emission rate detection sensitivity and probability of detection, as well as the relative actionability of each, or how geographically accurate a measurement is, which determines whether a repair crew can be directed to and mitigate a specific leak source. Certification bodies, regulators, and/or the research community should assess the performance of each technology not only in an experimental setting but via studies that assess the capabilities of the technology without any potential bias (e.g. by using double-blind studies), as well as periodically to ensure that performance standards are continually met.

Furthermore, evaluation of how multiple methane detection technologies might be used to supplement one another could inform how we best detect and reduce the largest possible mass of methane, thereby accelerating Canada's commitment to a 75% reduction of methane compared to 2012 levels by 2030.

15. What measures would accelerate deployment of methane reduction technology?

Regulatory approval of alternative technologies either basin-wide, province-wide, or federally, instead of the operator-by-operator Alt-FEMP application process would accelerate the deployment of methane reduction technologies. Please see responses to Questions 2 and 3.

16. What limits the deployment of methane reduction technology?

Agency approval for alternative methane emission detection technologies is the largest barrier to utilizing advanced methane detection and reduction technologies.

Additionally, environmental operating conditions can be a barrier to methane detection technologies.

17. How should a centre for excellence on methane detection and elimination be leveraged to support strengthened methane regulations?

A centre for excellence on methane detection and elimination should fulfill the role of a trusted third-party body that assesses the actual capabilities of various methane detection technologies.

Acknowledgments

Bridger gratefully acknowledges the many operators and organizations that made the emissions distributions shown in Figure 1 possible. Bridger also gratefully acknowledges the contributions of the Matt Johnson group at the University of Carleton for their work to make the Alberta emissions distribution and analysis possible. Bridger appreciates the opportunity given by ECCC to comment on the Discussion Paper.

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