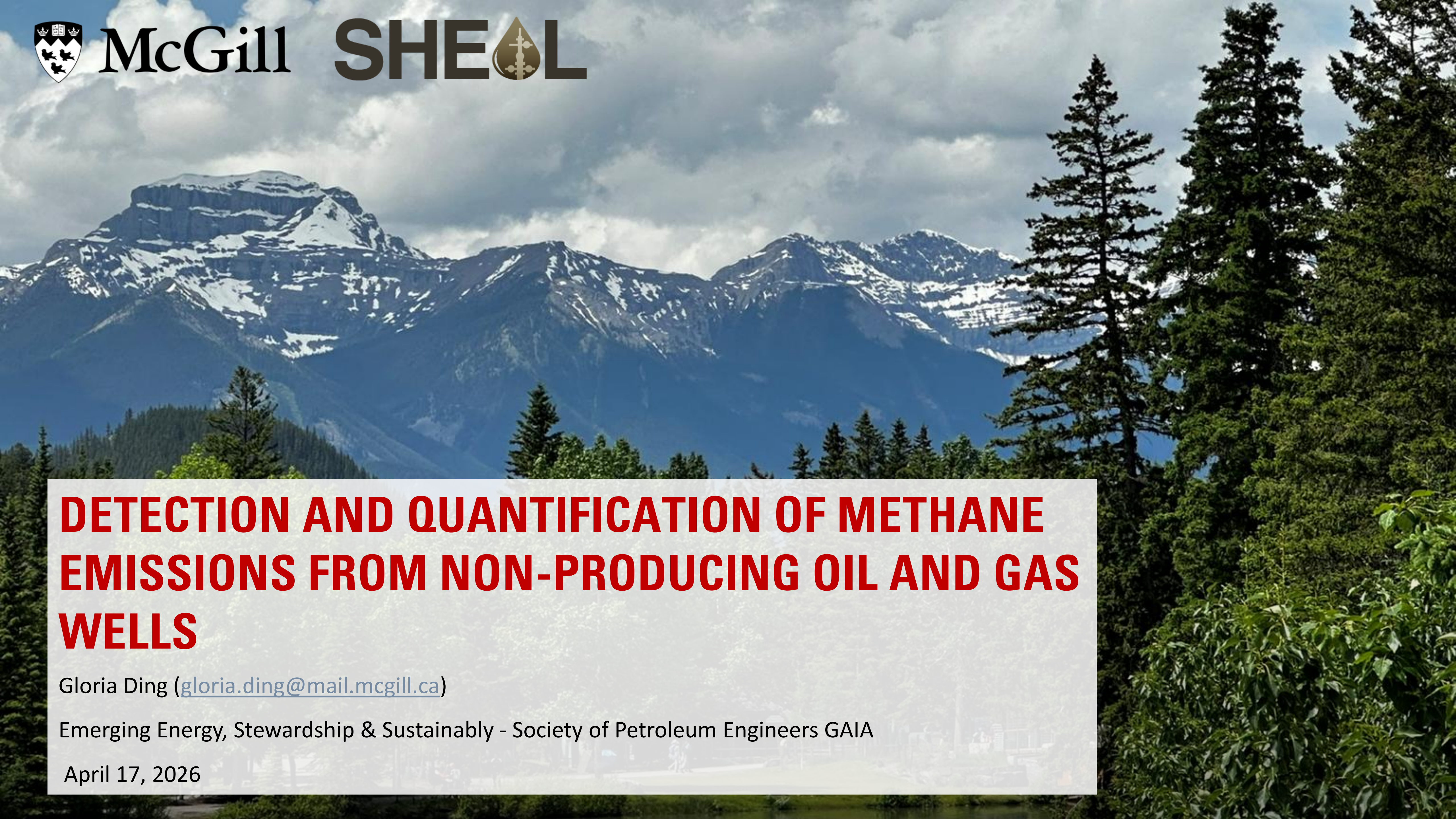

DETECTION AND QUANTIFICATION OF METHANE EMISSIONS FROM NON-PRODUCING OIL AND GAS WELLS

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INTRODUCTION

Greenhouse Gases and Methane

- Methane is a potent greenhouse gas, roughly 80 times more powerful at trapping heat than carbon dioxide over a 20-year period.[2]
- The oil and gas sector is one of the largest sources of methane emissions in Canada and offers many economically and technically feasible options for methane mitigation.[3]
- In 2023, 20% of total Canadian exports were crude oil, natural gas liquids, and natural gas, totaling $152 billion.[3]

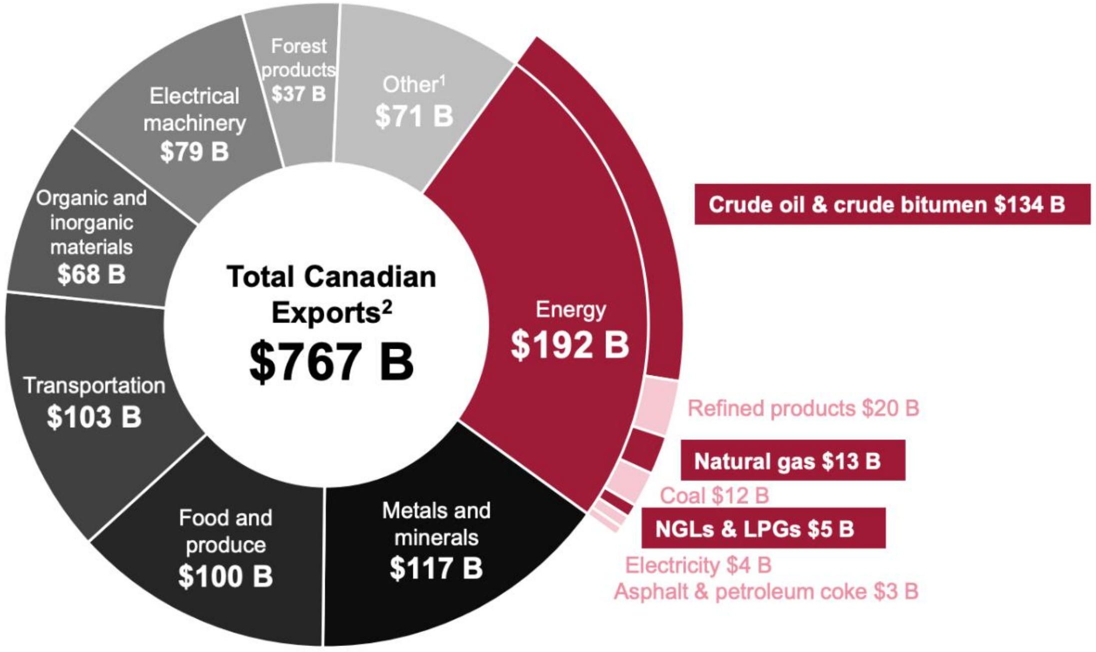


Figure 1 Total energy Canadian exports in 2023 showing oil and gas products totaling $152 billion in the Energy sector[3]

INTRODUCTION

Non-producing oil and gas wells in Canada

- There are ~200,000 actively producing oil and gas wells in Canada.
- 70% total drilled wells in Canada (~470,000) are no longer producing valuable hydrocarbons but still have the potential to be an environmental hazard, for example by emitting methane [4]
- Non-producing wells remain one of the most uncertain sources in the Canadian National Inventory Report and other national inventory reports.[4]

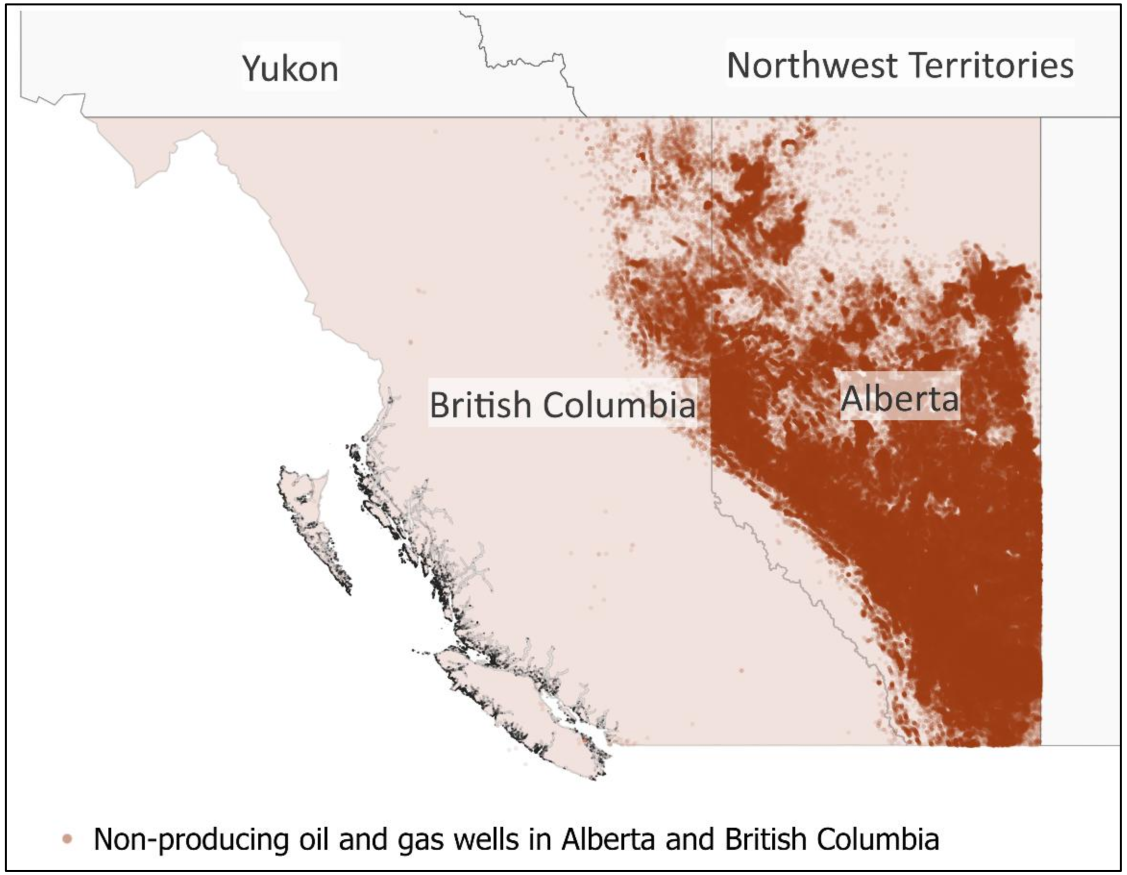


Figure 2 Non-producing oil and gas wells in Alberta and British Columbia

INTRODUCTION

Non-producing oil and gas wells in Canada

- Below is what we categorize as non-producing wells

Table 1 Subcategorization within non-producing wells in Alberta and British Columbia

Province/State	Well status	Plugging Status
Alberta	Abandoned	Plugged
	Abandoned and whip-stocked	
	Abandoned and re-entered	
	Abandoned zone	
	Junked and abandoned	
	Suspended	Unplugged
British Columbia	Abandoned	Plugged
	Abandoned Zone	
	Suspended	Unplugged

INTRODUCTION

Methane emissions from non-producing wells

- Previous studies show that non-producing well's methane emissions vary by more than 7 orders of magnitude.[5,6,7] We've seen that the top 10% of emitters (>21,000 mg/hr or >0.02 kg/hr) account for more than 99% of all emissions.
- There is an opportunity to further develop Canadian standards that incorporate a range of methane detection and quantification methods in support of the proposed federal methane regulations.

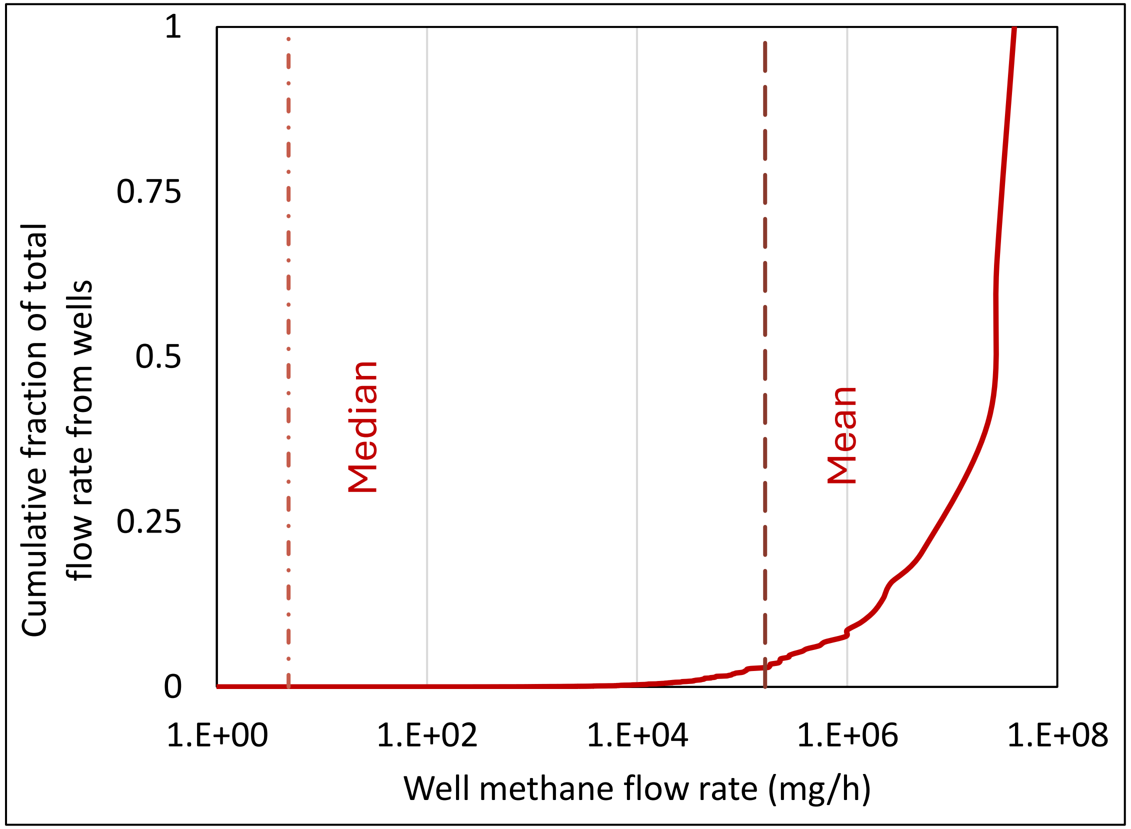


Figure 3 Measured non-producing wells database from SHEAL 2018-2025 field campaigns

NEW CANADIAN REGULATIONS

Environmental Climate Change Canada – Enhanced Methane Regulations

- Environment and Climate Change Canada (ECCC) Enhanced Methane Regulations (EMR) is expected to take full effect in 2028
    - Requires annual and screening inspections of inactive facilities, including non-producing oil and gas wells.[8]
- Annual inspections must be performed by a third party and have a 90% probability of detection of at least 10 kg/h.[8]
- Screening inspections must use a monitoring instrument capable of detecting fugitive emission sources with a flow rate of 10 kg/h or more.[8]

NEW CANADIAN REGULATIONS

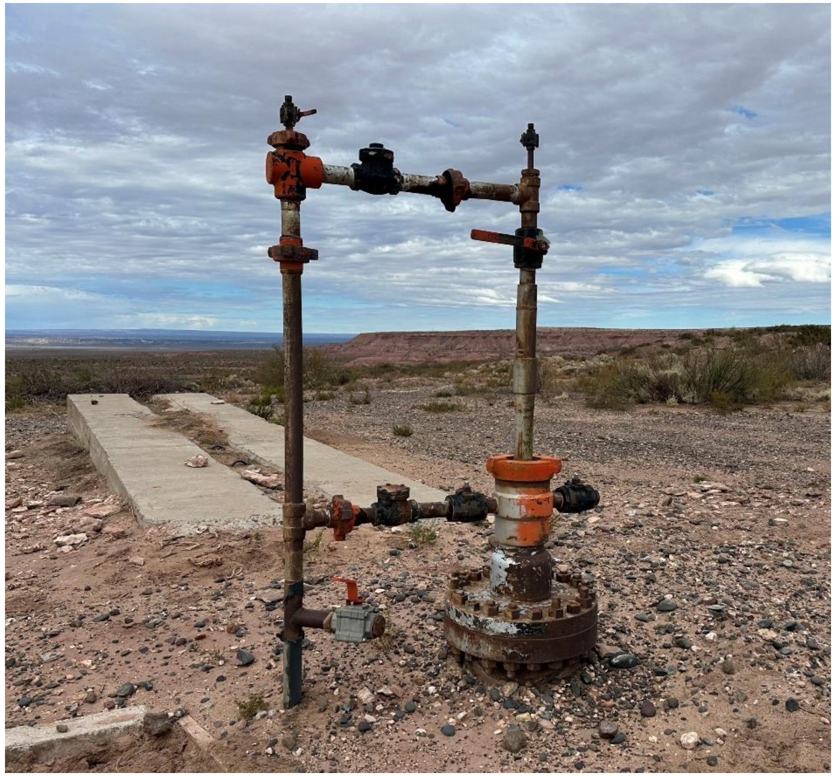
Canada-Alberta Methane Equivalency Agreement

- Provinces can develop equivalent regulations instead of directly following the federal regulations.
- In late March of 2026, Alberta signed the Canada–Alberta methane equivalency agreement, which is expected to be released later this year to provide an outcome-based equivalent for the province.[9]
- It is expected to take effect no later than January 1, 2027, and to last 10 years. [9]

NEW CANADIAN REGULATIONS

Canada-Alberta Methane Equivalency Agreement

- Since inspections defined in Canada's Enhanced Methane Regulations are expected to come into force in two years, and it is anticipated that something similar will come into force in Alberta in less than one year, we need to identify methane measurement methods to establish practical, efficient, and effective quantification standards.



EXISTING STANDARDS

Ground-based Gas Measurement Standards in North America

- The Air Emission Measurement Center (AEMC) at the Environmental Protection Agency (EPA) developed Method 21 for locating fugitive emissions of volatile organic compounds, which has acted as a basis for other fugitive emissions standards in North America.[10]

- Method 21 uses portable instruments to probe the surface of infrastructure to detect and classify fugitive emissions from individual sources.[10]

- In Canada, Method 21 was directly adapted for use in the Regulations Respecting Reduction in the Release of Methane in 2020 (SOR/2020-231).[11] The required instrument detection sensitivity level is 60 g/h.[11]

Government of Canada

EXISTING STANDARDS

Aerial-based Gas Methodology in North America

- In 2025, the U.S. Environmental Protection Agency (EPA) accepted the Alternative Testing Method (MATM 002) for airborne gas mapping LiDAR to identify, localize, and quantify methane emissions.[12]
- Within Canada, LiDAR-based aerial surveys have been accepted by provincial governments and industry, with many approved proposals under Alberta's Alternative Fugitive Emissions Management Program (alt-FEMP).
- Unlike the EPA's MATM 002, Canada has not developed a standardized methodology under which LiDAR-based aerial surveys can be conducted to meet the requirements of the ECCC EMR.

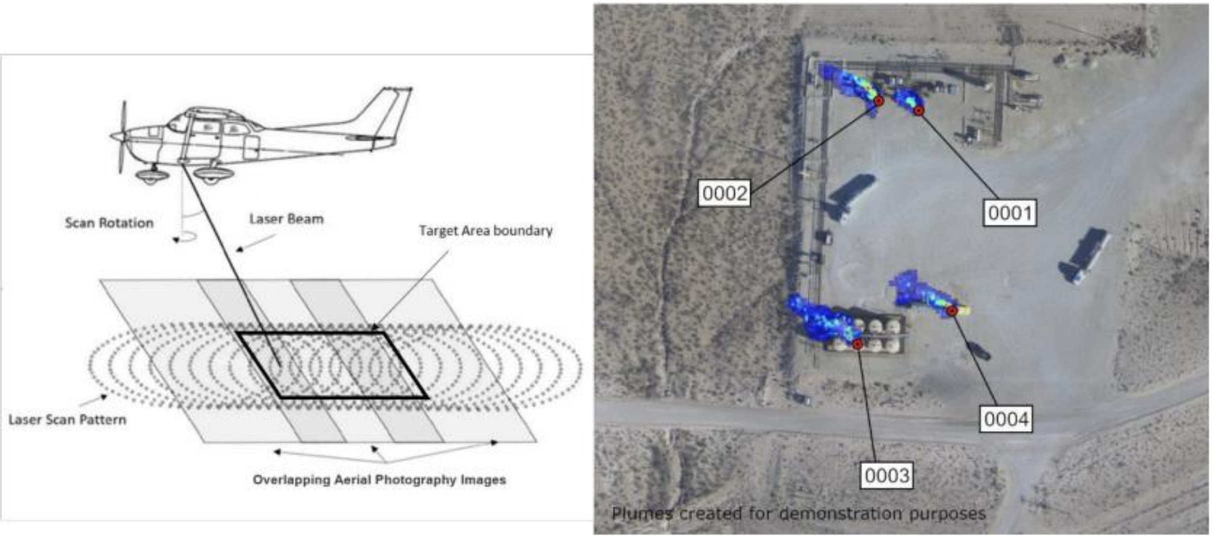
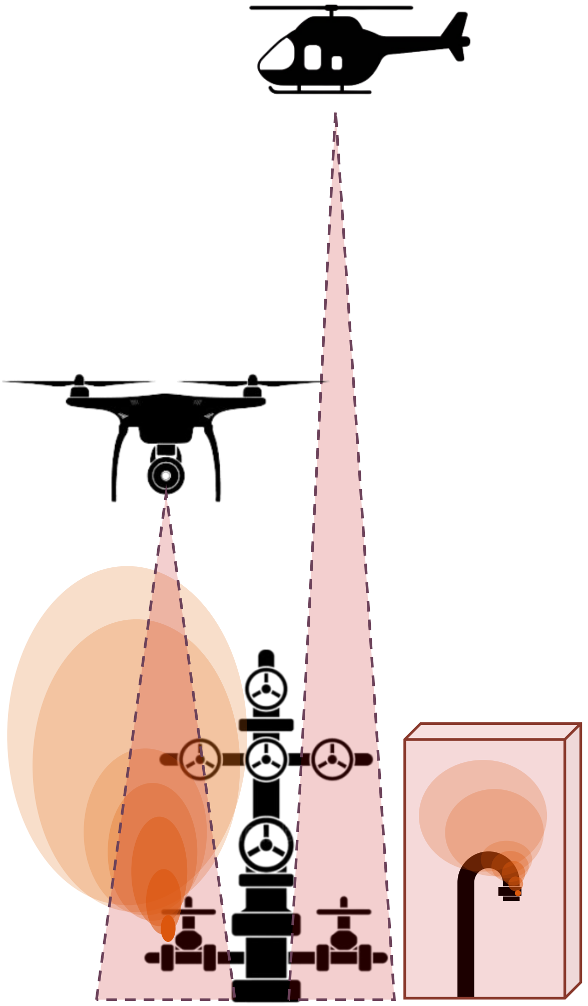


Figure 4 Conceptual diagram of Bridger Photonics MATM-002 proposal to EPA showing laser beam scanning within target area to show methane plumes from emission sources.[12]

PROJECT SCOPE

- By testing various ground-based and aerial-based detection and quantification strategies, we can provide industry with reliable, efficient, and effective methodologies to help compliance with Enhanced Methane Regulations/Alberta Equivalent.
- Ground-based and aerial-based measurements each have different advantages that can guide deployment.
    - Ground based measurements, such as static chambers, can reliably detect and quantify a wide range of methane emissions but face logistical challenges that limit deployment at some sites.
    - LiDAR-based helicopter surveys are more time efficient but are less effective at detecting emissions.
    - Drone deployment can be a great solution for difficult to access source locations but needs methodology development for detection.



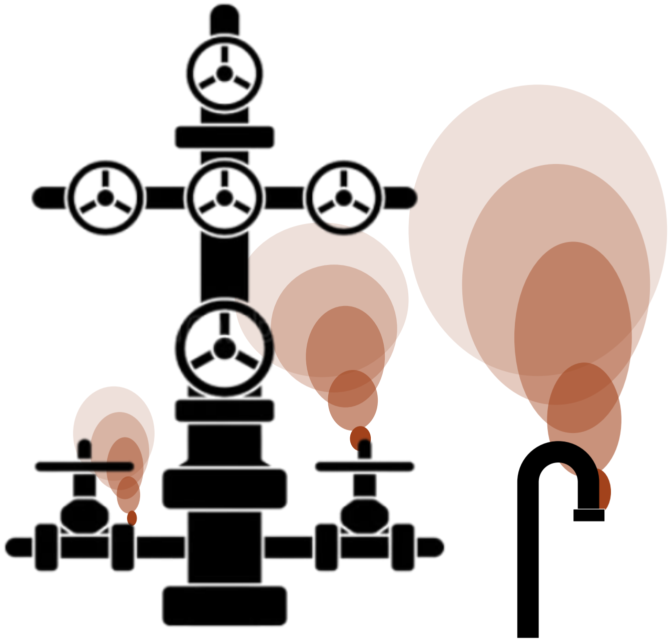
PROJECT SCOPE

Direct Ground-Based Measurements in Alberta

- 100 non-producing oil and gas sites will be measured using direct ground-based techniques in Summer 2026

Simultaneous Multiscale Detection and Quantification in Alberta

- Direct static-chamber measurements paired:
  - LiDAR-based helicopter survey over a subset of measured non-producing wells, controlled release of a range of methane flow rates to test helicopter probability of detection limits
  - Drone-based survey of measured non-producing wells, and controlled release testing[14]



GROUND-BASED METHODS

Static Chamber Technique

- Static chambers can reliably measure a wide range of methane emissions on an infrastructure component basis (wellhead, surface casing vent, and other infrastructure).
- This technique is labour- and time-intensive to deploy at every site and limited by physical access. It might not be a practical solution to meet the Enhanced Methane Regulations inspections at many sites.
- However, since it is a reliable, tested method, it will be deployed at every site we visit on the ground and will allow us to compare observed emissions with other technologies' readings to understand sensitivity.

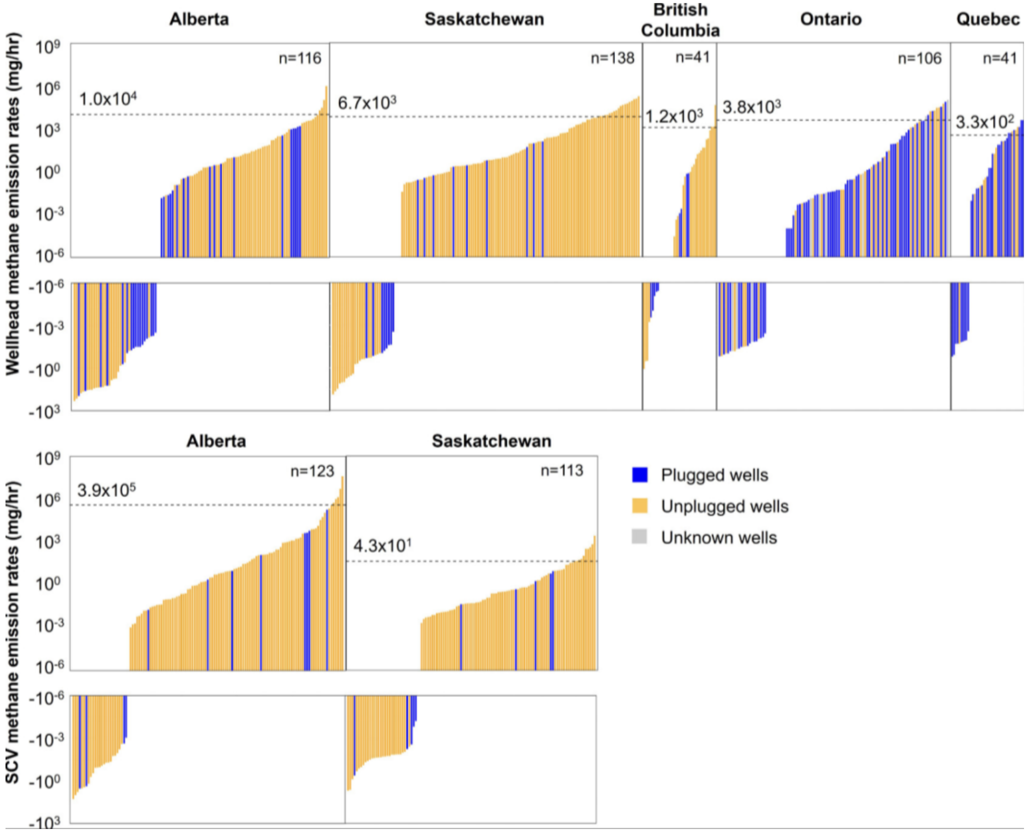


Figure 5 Methane emissions measurements using static chamber on an infrastructure component basis[5]

GROUND-BASED METHODS

Other Techniques

- We will deploy other ground-based methods such as high-flow samplers, mass flow meters, and infrastructure screening technologies.
- By testing many ground-based strategies, each with different costs, ease of deployment, and detection limits, we hope to inform industry on practical, efficient, and deployable methodologies for the Enhanced Methane Regulation screening inspections.

AERIAL-BASED METHODS

LiDAR-based helicopter survey

- LiDAR-based helicopter surveys used by the British Columbia Energy Regulator over non-producing oil and gas wells.
- These surveys provide detection classifications of “no detect”, “low”, “medium”, or “high” during each pass over a well.
- LiDAR-based helicopter detection appears promising, with a 90% probability of detection well below 10 kg/h needed for the Enhanced Methane Regulation.

Gaps

- Attributing LiDAR-based helicopter detections to potential methane emission quantification ranges in a variety of settings.
- Determining the proportion and rates of missed low emitters.

AERIAL-BASED METHODS

Informing detections with simultaneous measurements and controlled releases

- First, a static chamber will be deployed to determine the site level emission rate. After the static chamber is removed, seven aerial passes will be conducted over each site which results in seven separate detection classifications.
- By pairing direct static chamber measurements with detection classifications, we can attribute combinations of classifications to corresponding quantification ranges.
- For the controlled release experiments, known methane flow rates will be emitted, allowing us to develop probability of detection curves for the LiDAR-based aerial technology.
- This work can support of aerial-based methane detection framework in Canada for third party annual inspections.

AERIAL-BASED METHODS

Drone-based survey

- Using a mid-infrared methane and ethane drone-mounted sensor, the Aeris MIRA Strato, we will fly over non-producing wells to detect emissions.
- We will perform controlled releases of varying methane flow rates to test the sensitivity of the drone-based survey.
- This work can support the development of a framework for drone-based detection of methane in Canada to support **lower-cost** screening and annual third-party inspections.

Drone 1 DJI Matrice 600 Pro

Drone 2 DJI Matrice 300 RTK

CONCLUSION

- Canadian federal government or provincial equivalents will soon require regular inspections to quantify methane emissions from these non-producing sites.
- To meet these regulations, Canada needs reliable methods that can be consistently deployed with transparent interpretation of the data collected. North America has standardized methods to classify leaks using ground-based measurements; however, ground-based methods are labour-intensive and restricted by physical accessibility, making it unfeasible for all non-producing sites.
- We will test multiple ground-based and aerial based quantification and detection strategies to support technology standardization.
- By deploying multiple technologies that operators or energy regulators already have access to, we hope to support methodology development in a cost-effect way. Also, by recommending new technology and methods that provide reliable results we save operators time and money.

CONCLUSION

- This project will also combine ground-based measurements with LiDAR surveys over non-producing wells in Alberta. By comparing ground measurements with aerial detection results, we aim to develop a practical framework that allows emissions to be quantified based on aerial methane detection.
- This framework can be applied to other sectors for methane emissions quantification and detection.
- The results can support the development of Canadian standards, help industry cost-effectively comply with upcoming regulations, and improve methane mitigation efforts.

THANK YOU FOR LISTENING
QUESTIONS?

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