Bounding the Methane Emissions from Abandoned and Suspended Oil and Gas Wells in Western Canada

AUPRF Funding Application Review, November 28, 2024

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Abandoned Oil and Gas Wells: A Key Gap in Understanding

- How important are abandoned and suspended wells as a methane source? Should they be prioritized relative to other sources? Are current studies giving a representative picture?
  - Bowman, Hachem, & Kang (2023):
    - Methane emissions "37–50% higher than the National Inventory Report"
    - **Sample of 238 only**
    - *"This (one) measurement alone increased emission factor for unplugged wells by a factor of 2."*
  - Cahill et al. (2023)
    - "While emissions from some decommissioned unconventional wells may occur, natural soils-based oxidation may fully convert released CH_4 to CO_2"
    - **Sample of 10 only**


ENERGY FEATURED
Alberta Sets a Methane 'Super-Emitter' Record

By Andrew Nikiforuk, originally published by The Tyee December 12, 2023

Alberta owns a new record. The province is home to an abandoned and unplugged gas well that leaks methane, an explosive greenhouse gas, into the atmosphere at the

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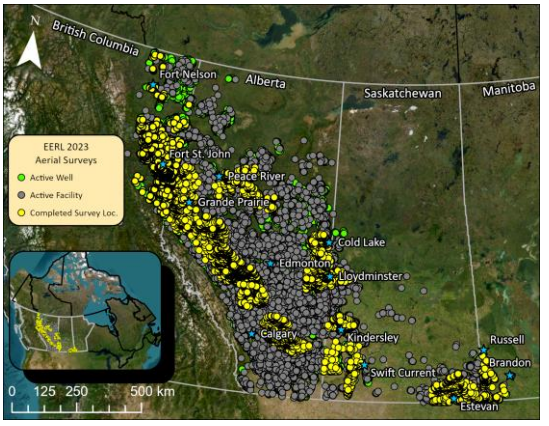
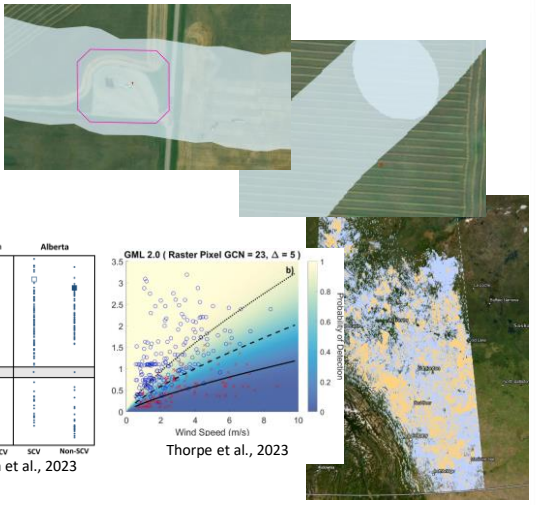
A Novel Approach to Bounding Methane Emissions from Inactive Wells

- An entirely new approach to understand and constrain the potential contribution of abandoned and suspended wells to overall methane emissions in the upstream oil and gas sector
  - Leverage current survey data for >15,000 sites across western Canada
  - Screen for serendipitous coverage of abandoned and inactive well sites
    - Estimated sample in the ***thousands***.
  - Using current ground study data as a starting point (prior), derive true distribution based (in)frequency of detection via detailed analysis considering site-specific POD



Methodology Overview

- Use a novel Bayesian analysis to estimate true distribution of abandoned wells considering all available literature data combined with large-sample aerial surveys
- Many important, time-consuming challenges, but all solvable building directly on expertise within EERL
  - Accurate mapping of abandoned & suspended well counts and locations at the specific time of each aerial survey pass
    - Careful consideration of inconsistencies in AER well data between license statues and well status modes for UWI in the same well etc.
  - Manual review of laser swath data for each site
  - Calculation and consideration of site- and pass/time-specific probability of detection for each pass of the airplane over each site
- However, scoping analysis suggests we should have >10-20 times larger sample than currently exists!



Bowman et al., 2023

Thorpe et al., 2023

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Key Team Members & Budget


Sangamithra Sakthivel


Emily Killeen


David Tyner


Matthew Johnson

- with additional support from entire EERL team

- AUPRF Budget request: 110K
  - 81.7 researcher time / salaries, 10K high-performance computing, 18.3K university overhead
- Leveraged funding (NRCan): 2.75 million

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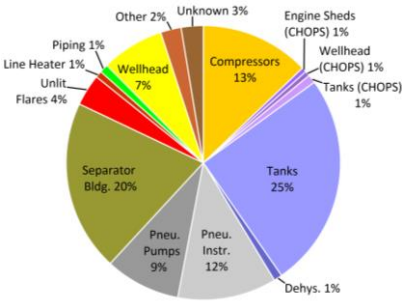
Anticipated Outcomes and Benefits

- Addressing methane emissions from abandoned and suspended wells has the potential to be extremely costly following current approaches
- This project will reduce uncertainty in the source distribution of abandoned and suspended wells, and ***quantify their relative contribution to overall methane emissions***
- This is critical to enabling:
  - Prioritized mitigation approaches that are both more cost-effective and impactful
  - Alternative risk-based approaches to mitigation based on refined knowledge of the underlying source distribution
  - Efficient data-driven regulatory strategies, or more directly, avoiding inefficient regulatory strategies

Alberta 2021 Inventory Sources



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Site Total Quantification of Methane Emissions with Drones Using New Downward Facing Laser Technology

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Site Total Methane Measurements: A Key Technology Gap

- Site total methane measurements:
  - Potentially the simplest way to screen for *emissions*
  - Invaluable for site-level reconciliation
  - Potential for an alternate, operator-deployed, site-level technology to complement large-scale, multi-site approaches like Bridger's GML
  - Possible using tracer-dilution approaches, but cumbersome and difficult
- New laser technology has unexplored potential

Site Total Technology Gap

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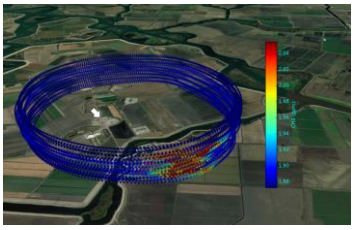
Solution Innovation

- Can new, commercially-available UAV (uncrewed aerial vehicle) mounted laser technology, primarily intended for source detection, be deployed to make quantitative site-total emissions measurements?

- Integrate UAV-mounted wind sensor, commercial ground-reflecting TDLAS laser, and customized software to quantify site total emissions via mass-balance
  - Additional option to compare with airborne point sensor
  - What accuracy can we achieve in a readily deployable platform?



Conley et al., 2017

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Methodology Overview

- Staged-complexity controlled release testing
  - Trials in to test ability to accurately quantify emission rates of encircled source(s) in increasingly complex scenarios
  - Requires
    - Accurate UAV-mounted wind measurement and characterization of uncertainties
    - Accounting for path-integrated nature (limitation) of the laser measurement in the context of varying wind with height
- Tests leveraging the AreaXO test site
  - Potential to include field trials on operator sites if sufficiently promising
- Thorough documentation of potential & limits of approach in an open-source protocol

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Key Team Members & Budget


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Milad Mohammadi


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- with additional support from entire EERL team

- AUPRF Budget request: 110K
  - 66.7 researcher time / salaries, 25K field work & consumables (methane, tubing, truck rental, etc.; AreaXO time), 18.3K university overhead
- Leveraged funding (Carleton/EERL/NSERC): 100K (incl. potential field measurements)

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Anticipated Outcomes and Benefits

- This novel approach offers a potential alternative & complimentary option to existing solutions, filling a key technology gap for site-total quantitative emissions measurements
  - Potential for an industry/operator-deployable technology based on commercially available hardware
  - Especially well-suited to emissions verification and reconciliation requirements in proposed regulations and standards such as OGMP2.0
- Test results and associated uncertainty measurements invaluable for both:
  - Potential use by industry in alt-FEMP or emissions reporting and mitigation
  - Understanding uncertainty limits in measurements made by others
- One key way to support goal of having a suite of methane technology options

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Updating Methane Inventories to Track Achieved Methane Reductions and Trends in Methane Intensity

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Accurately Tracking Reductions in Methane Emissions and Intensities

- AUPRF prioritized policy gap of "Improvements to the Methane Emissions Inventory, Accuracy, and Precision"
  - Quantifying and demonstrating achieved methane reductions and declining trends in methane intensity is fundamental to the continued success of Canada's energy sector
- In an era of unprecedented mitigation efforts throughout the oil and gas sector, maintaining precise, up-to-date inventories that accurately track achieved reductions and evolution of remaining sources is paramount to ensuring effective regulation and informed policy.
- This globally-unique, made-in-Canada project is defining and demonstrating first in the world protocols for creating measurement-based inventories that are placing Canada at the forefront of oil and gas sector methane mitigation.
  - The extension of this approach to quantify and track declining methane intensities creates an opportunity for Canadian operators to lead.

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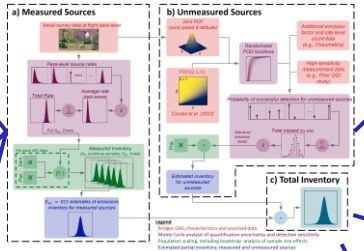
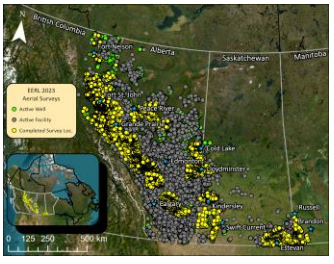
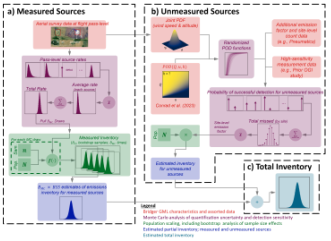
Solution Innovation



Methodology Overview

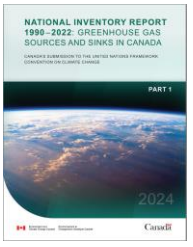
- Collaborative measurement effort with NRCan, BC Government, UNEP IMEO to quantify emission through 2024
  - Derive 2023 and 2024 measurement-based inventories for BC, Alberta, & Saskatchewan
- Key collaborative goal:
  - Quantify achieved reductions and trends through 2021–2024





- Comprehensive data sharing:
  - https://borealisdata.ca/dataverse/

- World-leading measurement-based inventories for official IPCC reporting:



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Key Team Members & Budget


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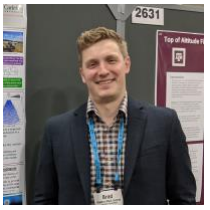

Bradley Conrad


Nikolai Calderon


Matthew Johnson

- with additional support from entire EERL team

- AUPRF Budget request: 110K
  - 81.7 researcher time / salaries, 10K high performance computing, 18.3K university overhead
- Leveraged funding (NRCan/BC Gov/UNEP): 4.75 million

Anticipated Outcomes and Benefits

- Quantifying and demonstrating achieved methane reductions and declining trends in methane intensity is fundamental to the continued success of Canada's energy sector.
- Regulations are ultimately limited by past understanding of emissions and assumed distributions of sources.
  - In an era of unprecedented mitigation efforts throughout the oil and gas sector, maintaining precise, up-to-date inventories that accurately track achieved reductions and evolution of remaining sources is paramount to ensuring effective regulation and informed policy.
- A detailed understanding of *evolving* methane sources and source characteristics is essential for targeted and cost-effective methane mitigation.
- The approaches pioneered through this project are ideally suited to meeting proposed audit requirements in new regulations at the *lowest possible cost* as well as supporting operator-specific reconciliation efforts under voluntary programs such as OGMP2.0.

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Acknowledgements

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Canada

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UN environment programme

IMEO

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PTAC
PETROLEUM TECHNOLOGY ALLIANCE CANADA

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