Seeing Methane,
the Invisible Problem …

Who is Using Which Number?

Oil & Gas Subcommittee Webinar

23 June 2020

Global Methane Initiative

Housekeeping – Tips for using Teams

Mute your microphone.

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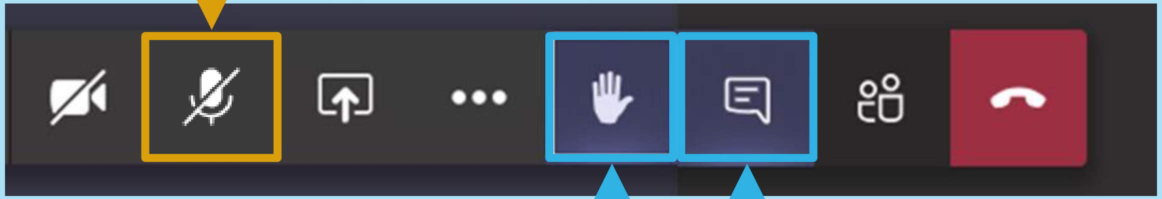
- If participating by phone, press *6 to mute your phone.



If available, use the "Raise your hand" button to be called upon to speak.

Or, enter questions using the "Chat" pane. Type "Raise My Hand" to be called upon to speak.

Help!

Need Help?

If you need help, please send an email to asg@globalmethane.org

Agenda

- Welcome
  - James Diamond, GMI O&G Subcommittee Co-Chair, Environment and Climate Change Canada (ECCC)
- Presentation from GHGSat
  - Stéphane Germaine, Chief Executive Officer, GHGSat Inc.
- Presentation from The Sniffers
  - Bart Wauterickx, Chief Executive Officer, The Sniffers
- Presentation from Energy & Emissions Research Lab
  - Matthew Johnson, Research Professor, Mechanical & Aerospace Engineering Energy & Emissions Research Lab., Carleton University
- Facilitated Discussion
  - James Diamond
- GMI Secretariat News and Updates
  - Monica Shimamura, Director, Secretariat
- Subcommittee News and Updates
  - James Diamond
- Wrap up and Adjourn

Objectives of the Webinar Series

- Cover topics that were on the agenda for the Oil & Gas Subcommittee meeting at the Global Methane Forum 2020
- Bring together policymakers, industry leaders, technical experts, and researchers
- Discuss how to adapt methane mitigation approaches to address current challenges
- Set the stage for the next Global Methane Forum

We welcome your feedback!

We encourage you to share suggestions for future webinar topics by emailing us at asg@globalmethane.org

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Realizing your Environmental and Sustainability Ambition

Global Methane Initiative

Seeing Methane, the Invisible Problem …
Who is Using Which Number

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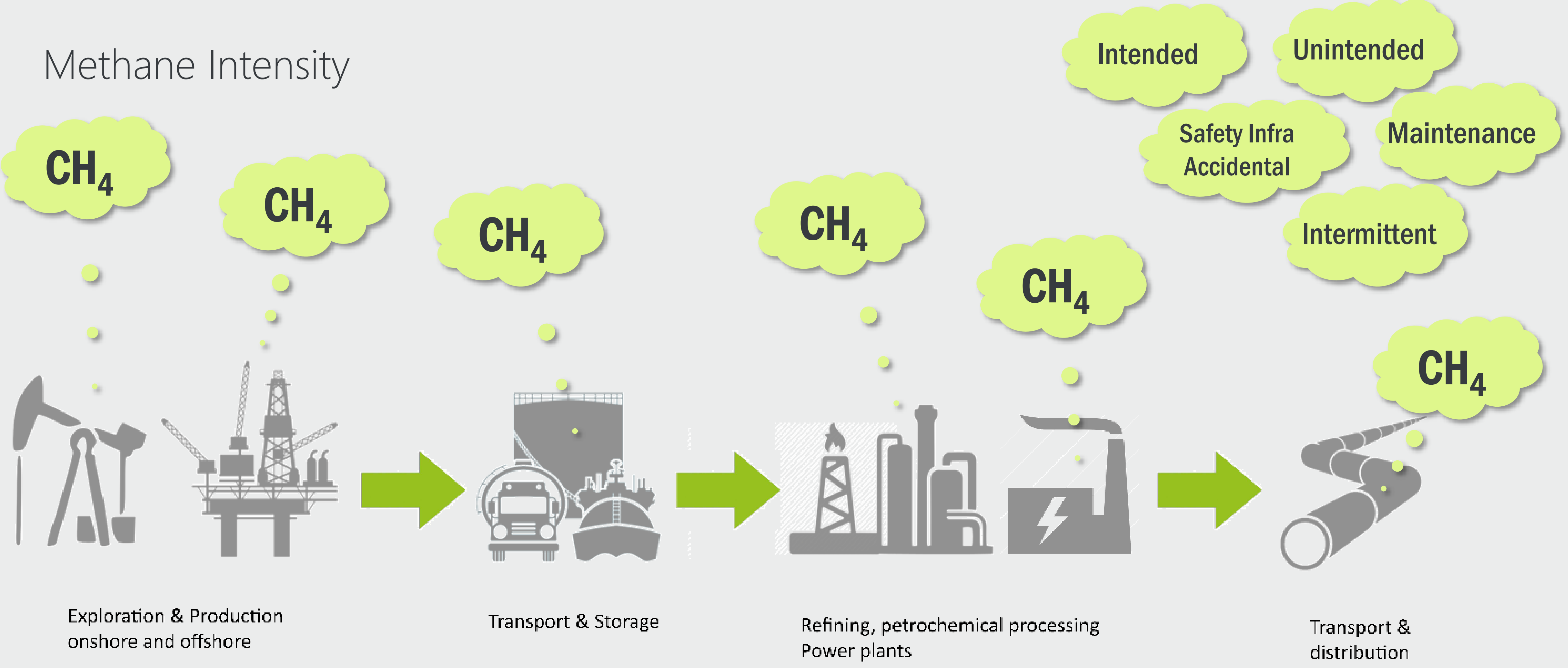
Oil & Gas Subcommittee Webinar
2020 06 23

Bart Wauterickx
CEO The Sniffers

Methane Emissions

How to Reduce?

Methane Intensity



Methane emissions throughout the complete value chain

What do we want?

- Understand current emission situation
- Positioning in the market
- Targets: Able to monitor improvements
- Data intelligence
- Reassurence: validation, prognoses…

Emission Data needs to be:

- Complete
- Reliable
- Traceable
- Actionable
- Comparable

How?

Inventorizing
Measuring
Structured programs: LDAR

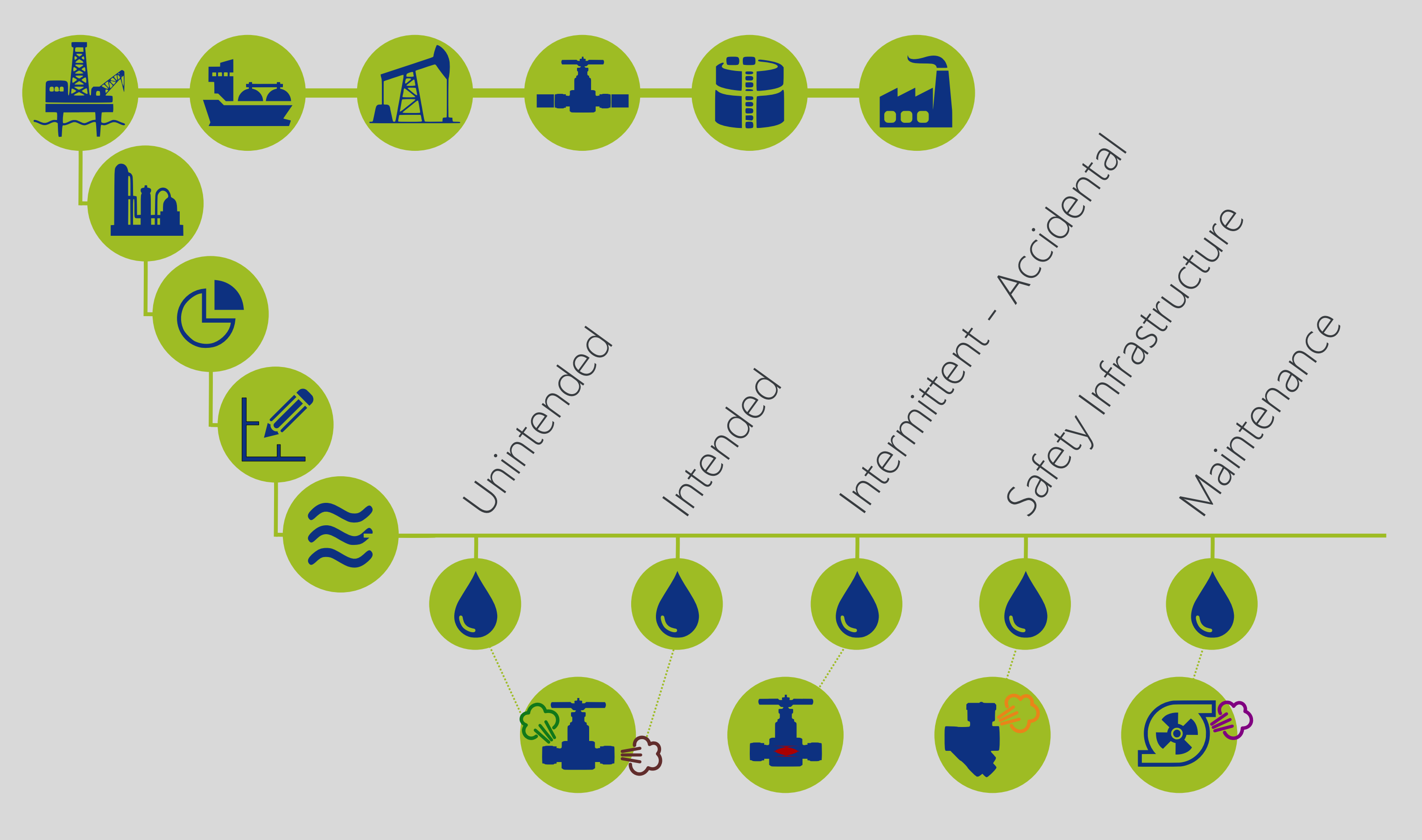
How not:

Estimating
Modelling
Random projects

Customers need reliable transparent emission data

1 Inventory

Inventorize E2E value chain with drilldown to source level



- Consider all emission types for each equipment
- Connect P&ID, emission source and composition
- Full Inventory required for certain protocols

Map product streams and compositions

Critical Success Factors for Sustained Methane Reduction

1 Inventory

2 Technology Agnostic

Understand Methane ambition and budget of the customer

Repair Threshold ?
1000–10000-100000PPM
50 -500 kg/year

Fit for Purpose Approach: Select correct Measuring Technique and Calculation Protocol

Critical Success Factors for Sustained Methane Reduction

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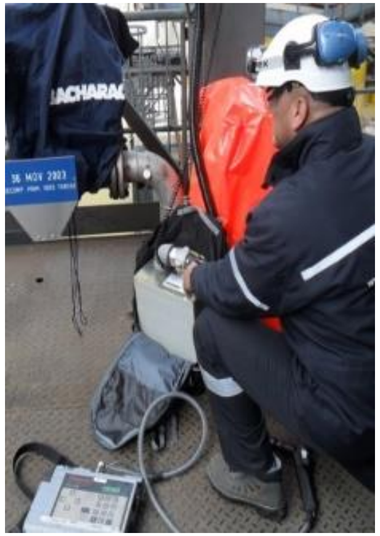
1 Inventory

2 Technology Agnostic

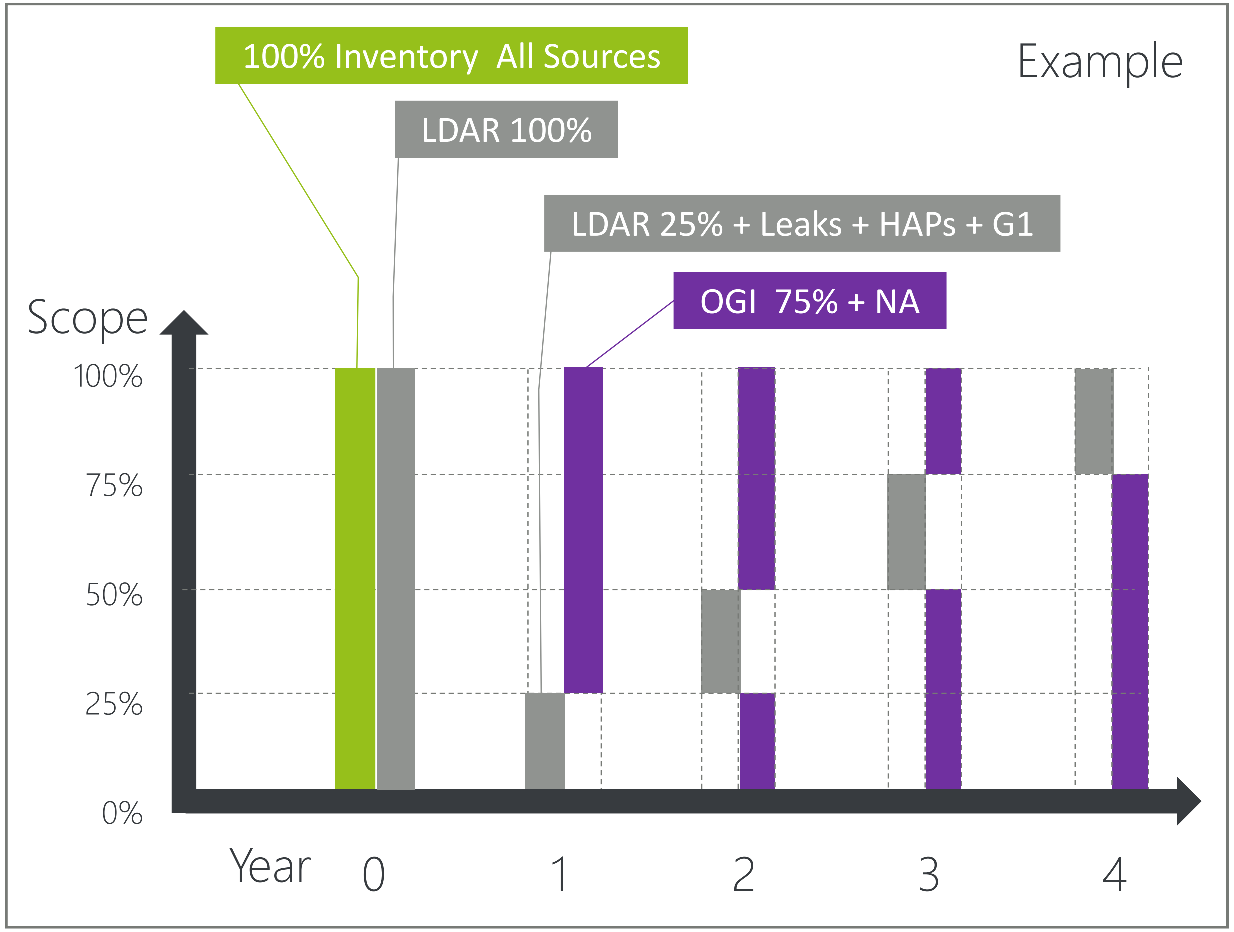


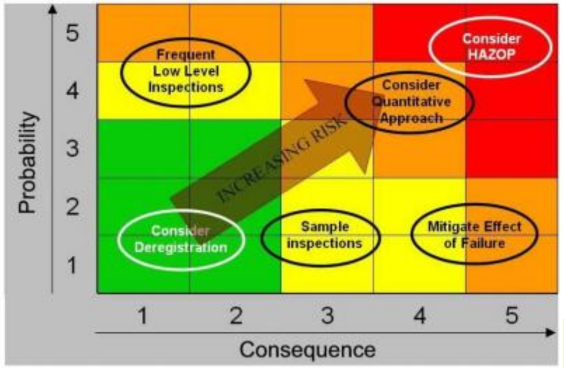
Critical Success Factors for Sustained Methane Reduction

1 Inventory

2 Technology Agnostic

3 Measuring Scope - RBI





Optimal Program

- Combine Measuring Techniques
- Apply principles of RBI
  Risk Based Inspection focused on most probable leaks and highest consequences
- Detect leaks >Repair Threshold
- 25% Scope limit costs and maximize value

Limited Investment for High Quality Program

Critical Success Factors for Sustained Methane Reduction

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1 Inventory

2 Technology Agnostic

3 Measuring Scope - RBI

4 Accreditation

Third Party Process Qualification

External confirmation of Protocol adherence – operator qualification, measurements, calculations, reporting

Warranty for a reliable report and credible figures

Suitable for regulatory reporting and stakeholder information

Critical Success Factors for Sustained Methane Reduction

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Critical Success Factors for Sustained Methane Reduction

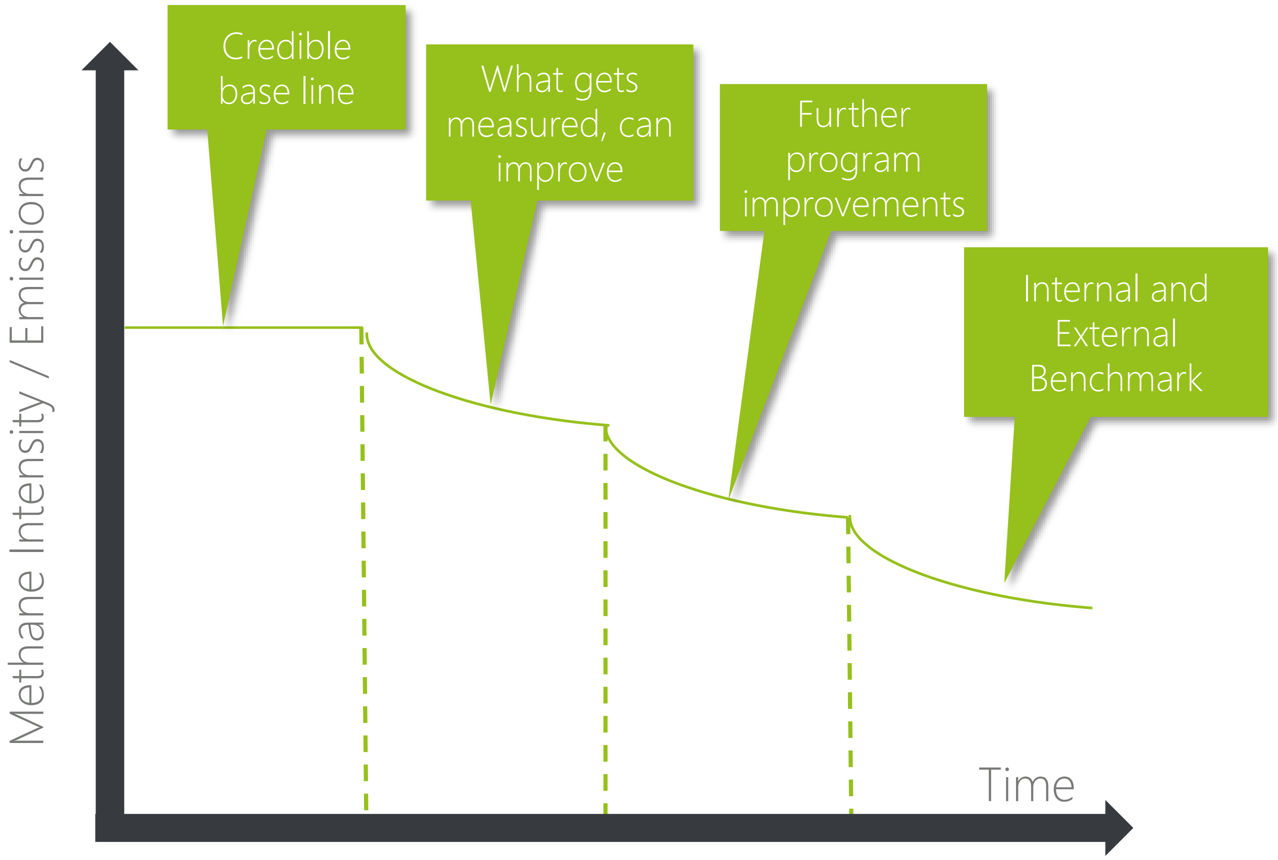
1 Inventory

2 Technology Agnostic

3 Measuring Scope - RBI

4 Accreditation

5 Continuous Improvement



Beyond classic repair techniques

Process changes & Investments

Benchmark:

- Reveal Best in Class Techniques
- Identify biggest improvement opportunities
- Knowledge Sharing
- Top quartile performance per source type, per function, per ...

Methane Reduction Results for 400 Campaigns

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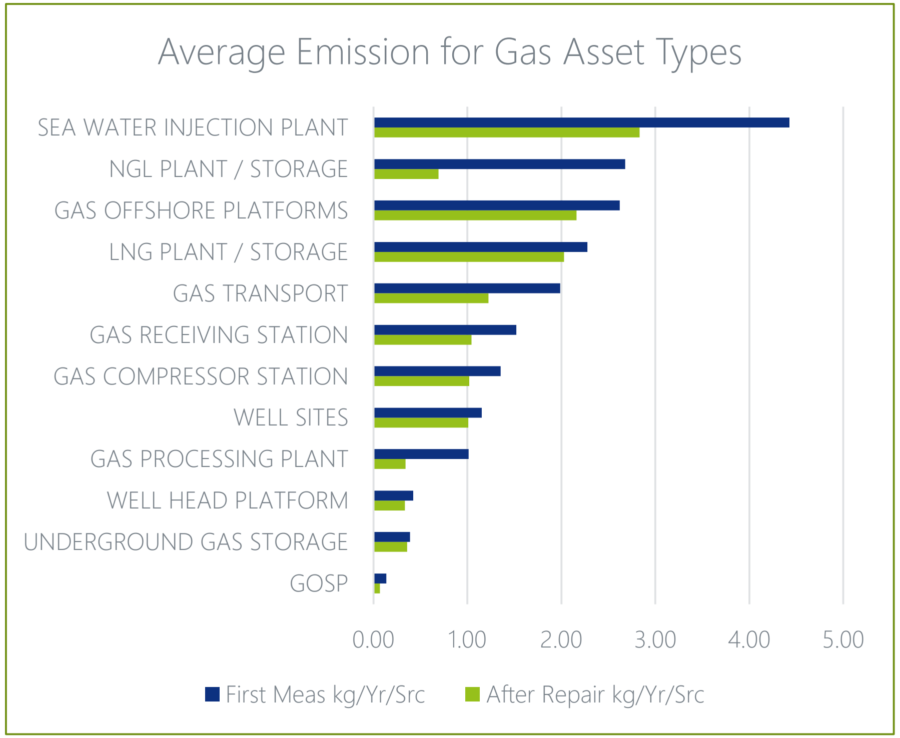
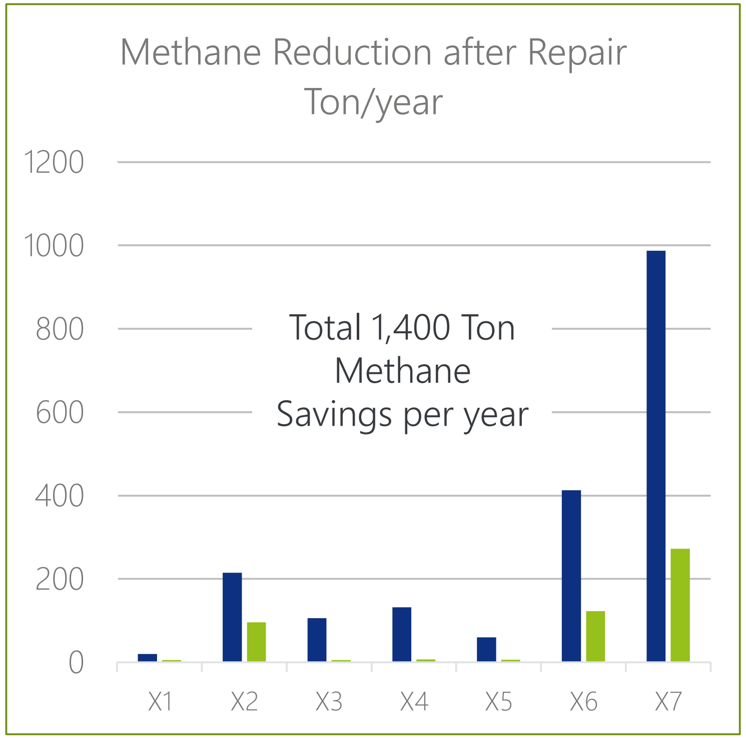


Methane Emission Reduction Results
in one-year, average figures per Gas Asset type,
400 LDAR campaigns,10mio measurements.
From 1,42kg/year/source to 0,92kg/year/source or -35%

Source Type	Initial Leak Mass per Leaking Source kg/year	After Repair Leak Mass per Leaking Source kg/year
Connection	156	100
Stem Valve	182	113
Flange	104	83
Stem Control Valve	248	189
Open End	547	507
Potential Open-End Connection	273	203
Relief Valve	889	695
Potential Open-End Flange	69	27
Pump Seal	91	76
Compressor seal	246	251
Sample Point	438	394
	181	127

Average mass leak kg/year for typical source types
in Gas Assets, 400 LDAR campaigns.
Average improvement:
from 181kg/year to 127kg/year for a leak

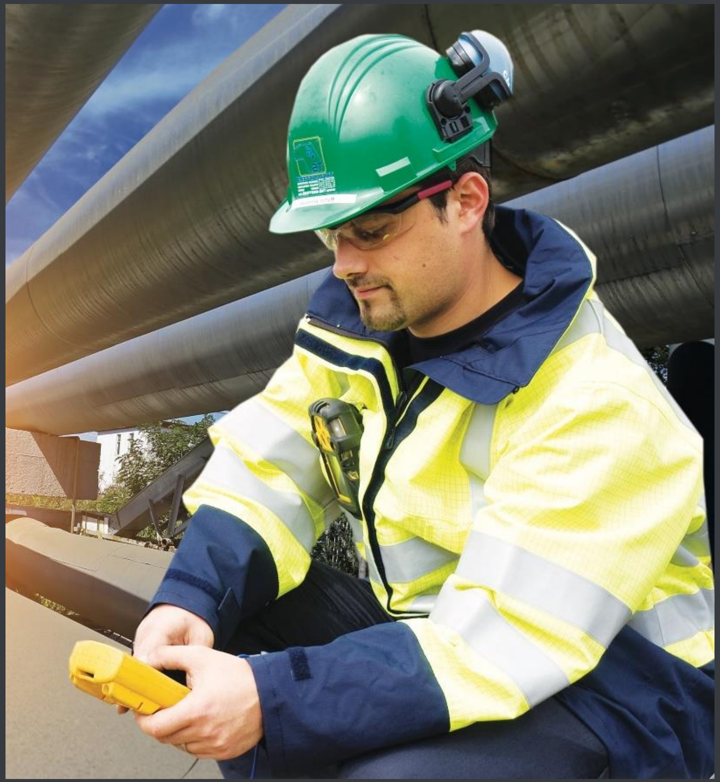


Benchmark Campaign results for 7 gas processing plants. Total 1 400 Ton Methane emission saving per year with a one-year campaign or-70%

Measuring Campaign Results and Insights

- Source based LDAR campaigns provide actionable data for repair and emission reduction
- Select measurement technology and protocol aligned to the repair threshold for methane
- Apply RBI to maximize value and lower cost
- Reliable data allows structural emission reduction. Yearly emission improvements of -35% up to -70%
- Benchmarking emission results reveal information for continuous improvement
- Third Party accreditation of service providers delivers a credible report and reliable emission figures

Conclusions



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Realizing your Environmental and Sustainability Ambition

Quantifying Methane at Different Scales

Aerial & Ground-Based Measurement Technologies to Drive and Track Mitigation

Global Methane Initiative, Oil & Gas Subcommittee Webinar, June 23, 2020

Prof. Matthew R. Johnson and Dr. David R. Tyner

Carleton University
Canada's Capital University

Energy & Emissions Research Lab.,
Mechanical & Aerospace Engineering,
Carleton University, Ottawa, ON

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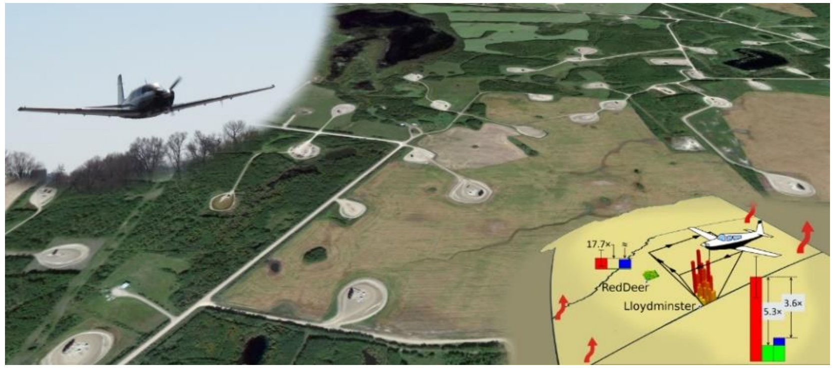
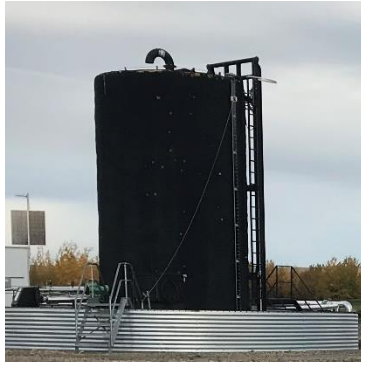
Quantifying and Mitigating Methane is a Multi-scale Challenge

- Need for better aggregate source quantification
  - Total inventories & tracking aggregate reductions
- Need for site level quantification and monitoring
  - Compliance with regulations
  - Screening for mitigation opportunities
- Need for source-level measurements
  - Source-specific regulations (e.g. compressors)
  - Key challenging sources may drive inventories (e.g. tanks)
  - Eng. design data - actual mitigation occurs at sources





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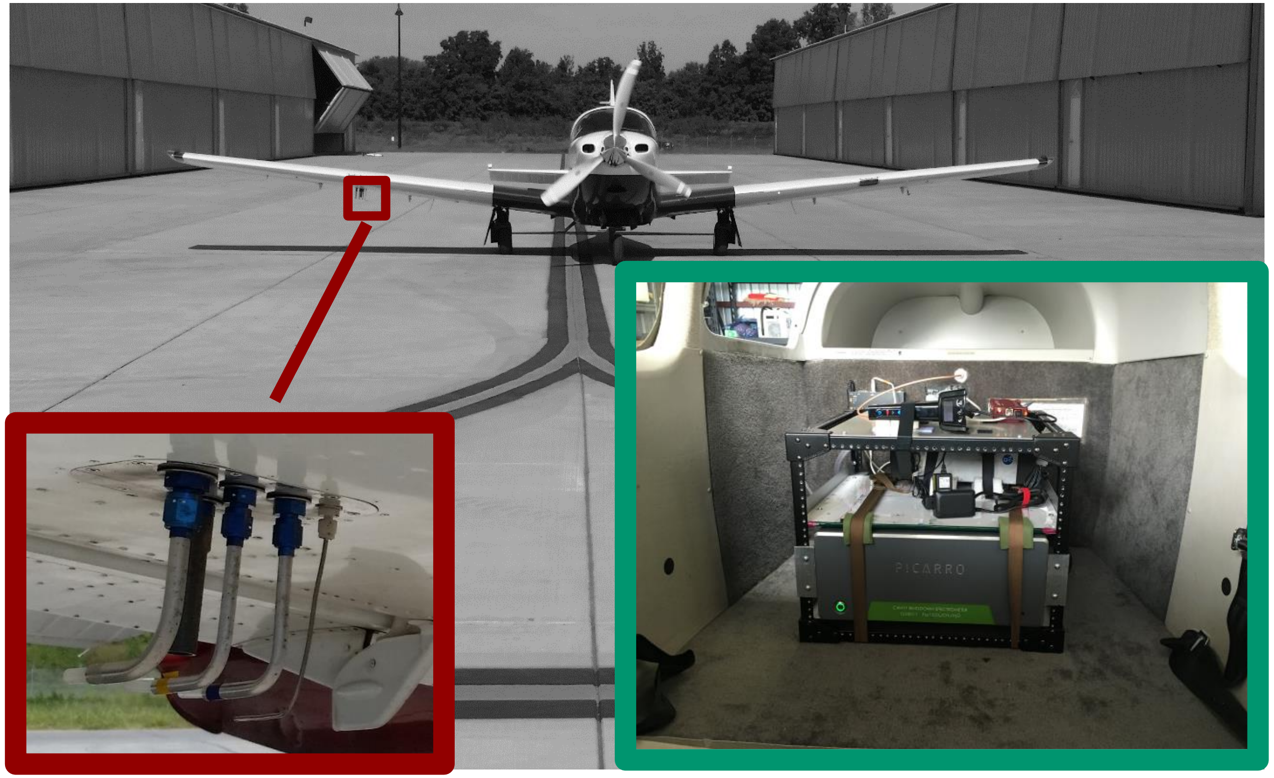
Regulatory Needs Vs. Technology Limits

- Alignment of inventories and tracking progress toward reduction targets
  - Requires accurate aggregate measurements across 1000s of sites
  - Challenging or impossible if only some portion of sites can be quantified
  - Critical task given continued significant persistent discrepancies between measurements and inventories *(e.g. Hmiel et al., Nature, 2020)*
- Sensitivity requirements to assess regulatory compliance
  - ECCC Site-level Venting Limit (Canada): 1250 m^3/mo = 1.7 m^3/hr ≈ **0.001 t/hr**
- Component coverage and measurement frequency
  - Many fugitive emissions programs based on screening components @ 1-3×/yr
- Accurate source-specific quantification **to enable actual mitigation decisions/design on the ground**

1. Aggregate Top-Down / Bottom-Up Analysis:

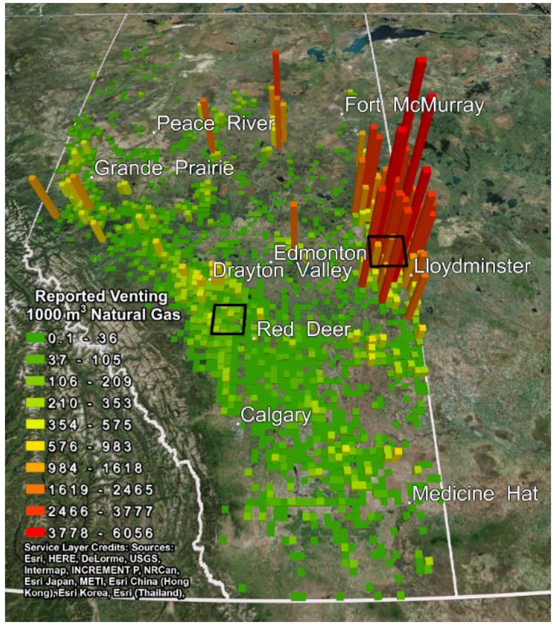
Contrasting Aerial Measurements with Inventories



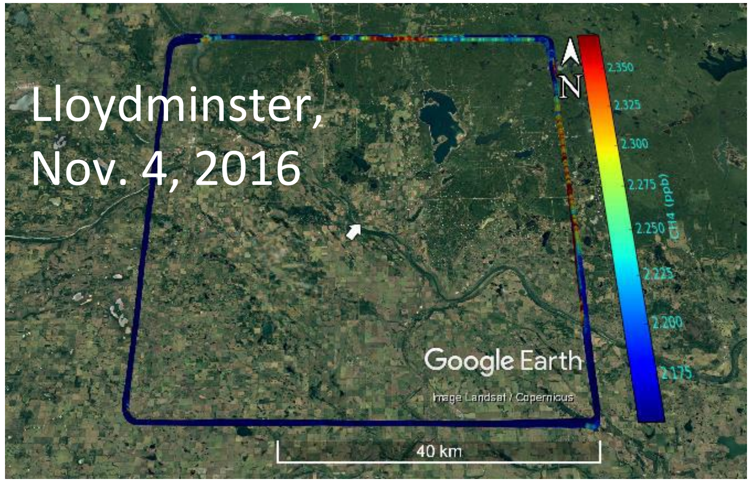
M.R. Johnson, D.R. Tyner, S. Conley, S. Schwietzke, D. Zavala-Araiza (2017), *Environmental Science & Technology*, 51(21):13008-13017. (doi: 10.1021/acs.est.7b03525).

Aggregate Site Top-Down Quantification - Flight Plans and Sample Data

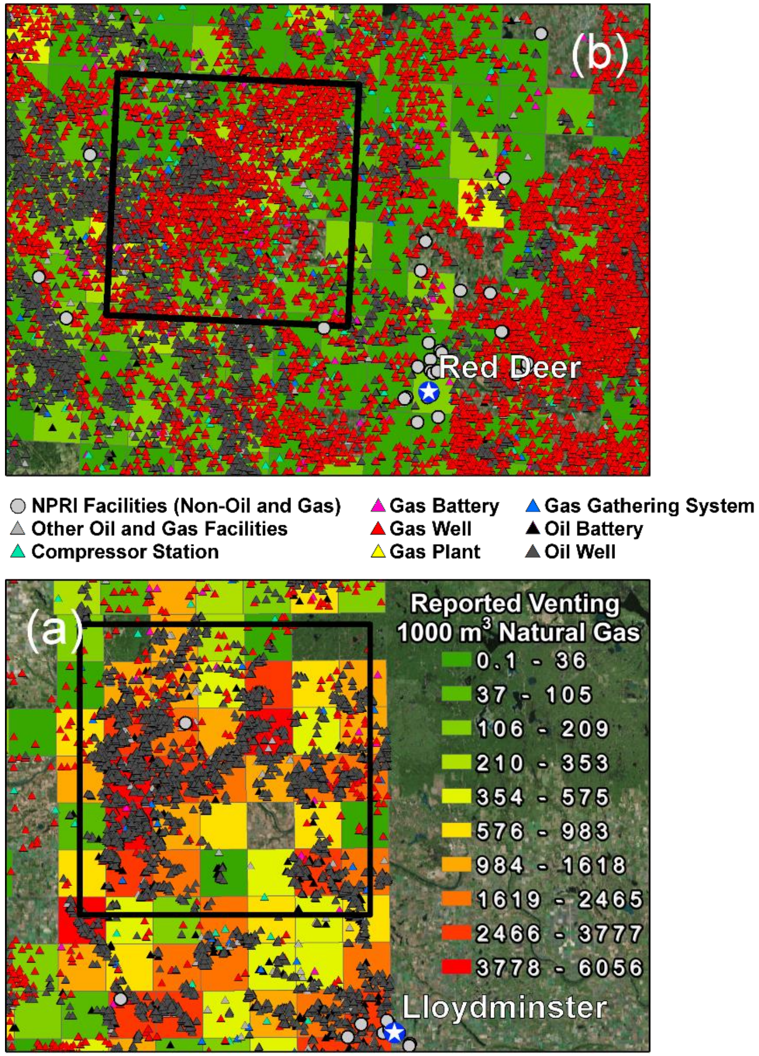
- Two contrasting regions
- Multiple flights over several days in Nov. 2016
- Direct comparisons with reported / inventory data



Sample Flight Data



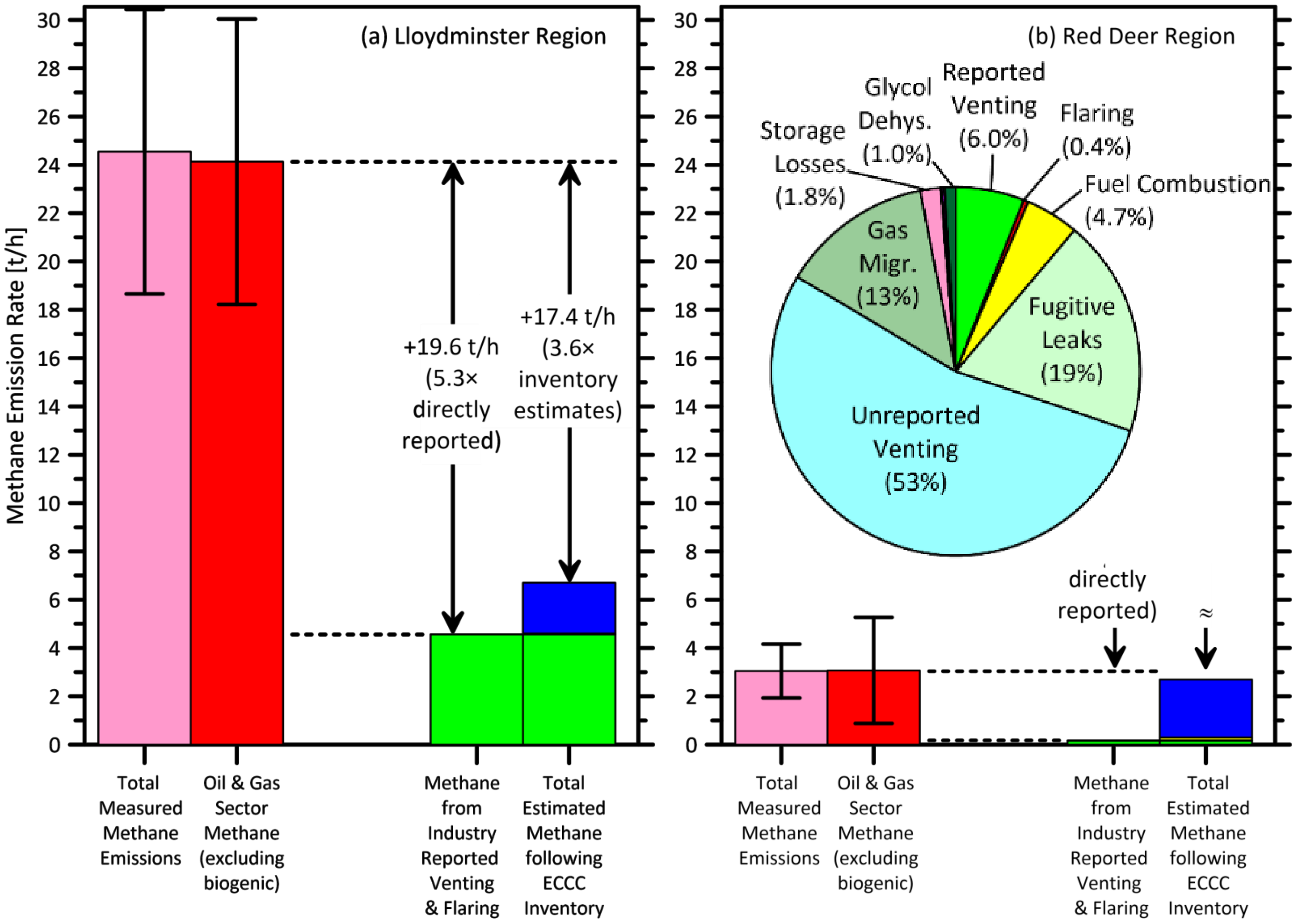
Reported Production Data



Aggregate Top-Down / Bottom-Up Analysis:
Contrasting Aerial Measurements with Inventories

Implications

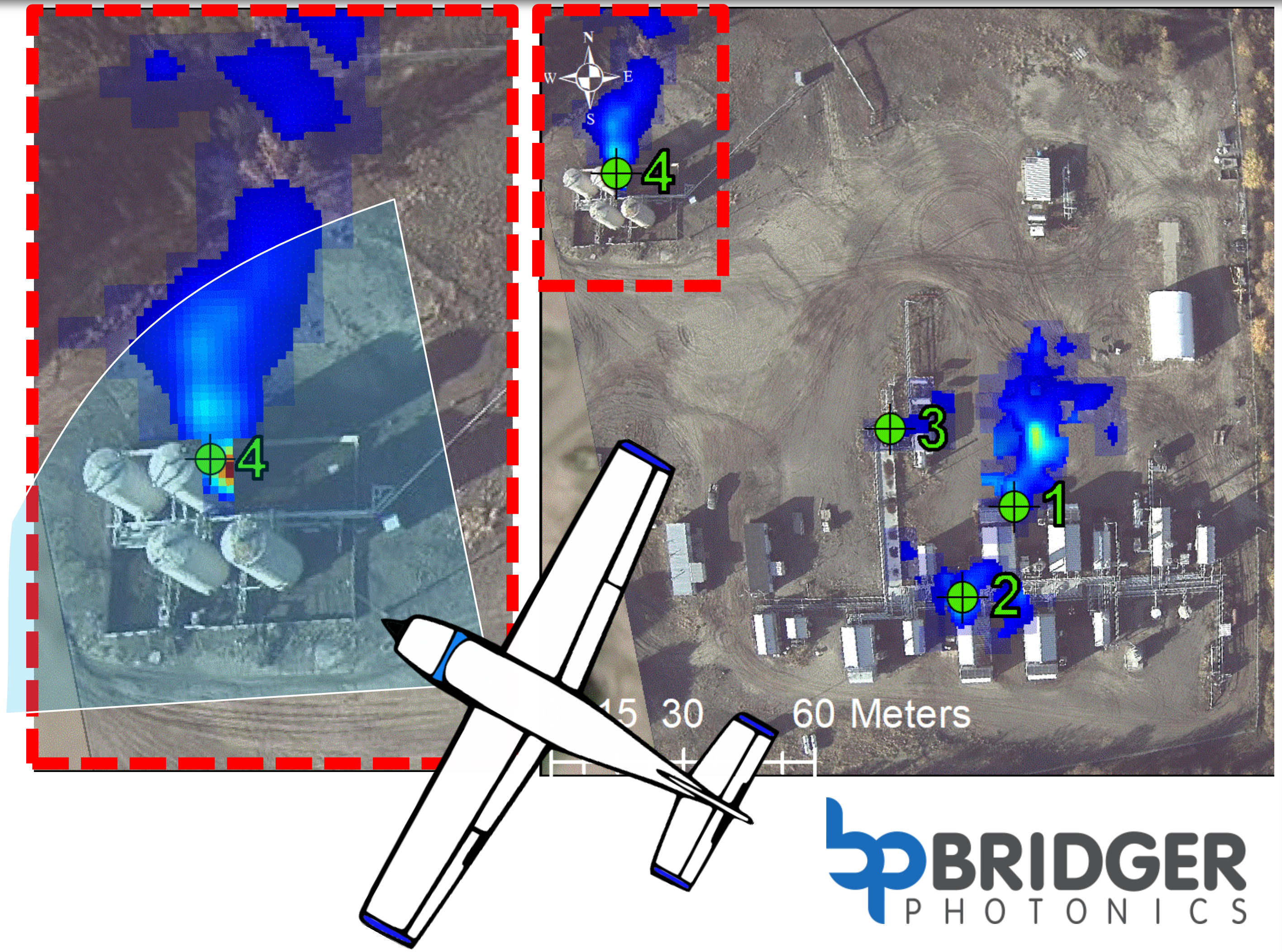
- Measurements in Lloydminster (Heavy oil region) **3–5× greater than both reported and inventory estimates**
  - Underreported venting at heavy oil production sites
- Measurement in Red Deer match inventory but show that **~94% of methane from unreported fugitive sources**
- **Actual methane emissions from the conventional oil and gas sector at least 25–50% greater than estimated**



Johnson et al. (2017), *ES&T*, (doi: 10.1021/acs.est.7b03525).

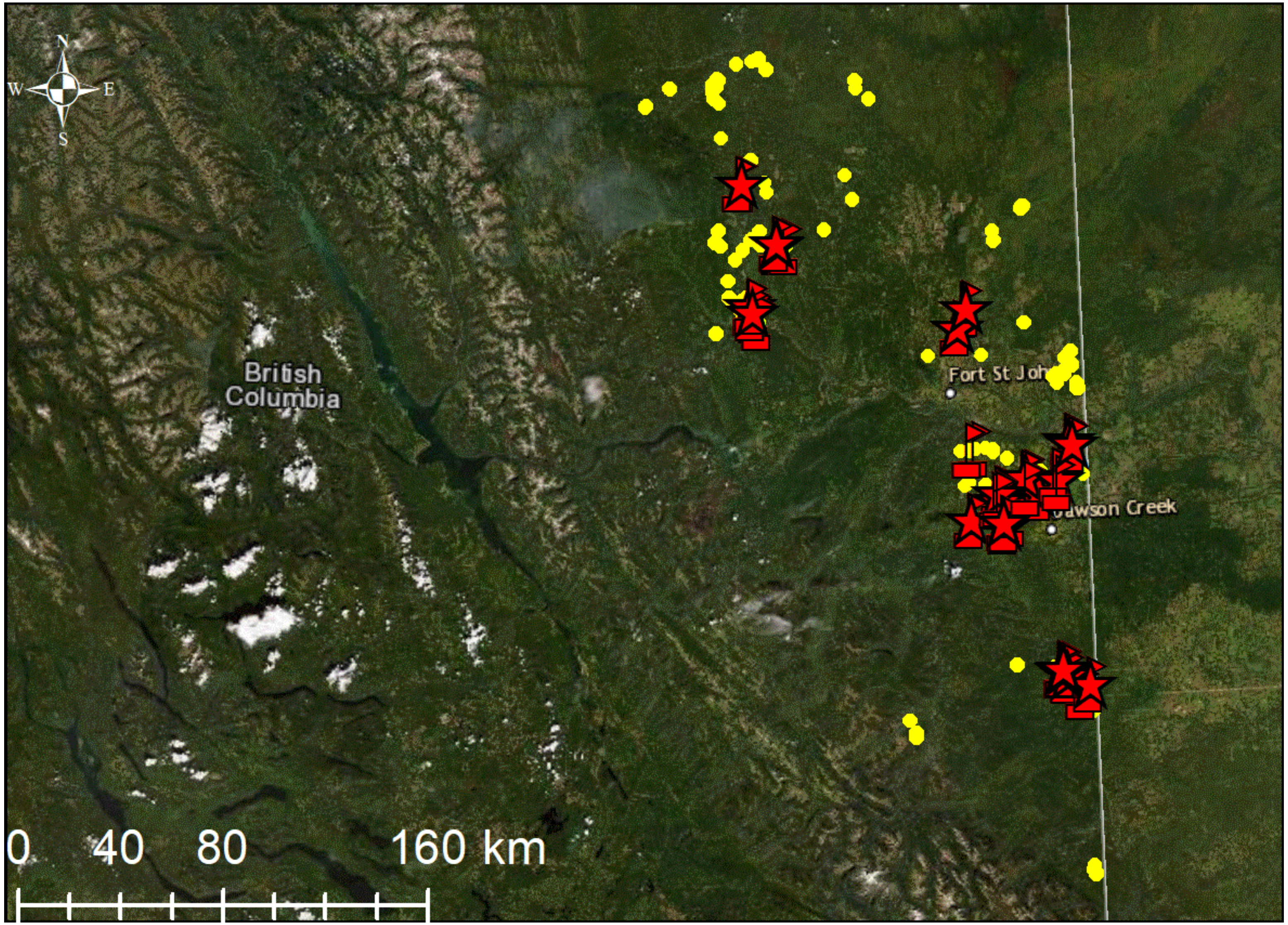
2. Site-Level Top-Down / Bottom-Up Analysis :
Contrasting Aerial Measurements with Ground Measurements

- Novel LiDAR technology (Bridger Photonics)
  - Can measure individual plumes
  - Recent trials in Northern British Columbia
- Lower Sensitivity (~1.2-2.0 kg/hr)
  - Validated by EERL using in-field blinded tracer releases
  - Sufficient to assess some regulatory limits
    - AER "defined vent limit" = 3000 m^3/mo ≈ 2.5 kg/hr
    - ECCC site vent limit = 1250 m^3/mo ≈ 1.0 kg/hr



Aerial Methane Measurement Survey September 2019

- Aerial methane measurements
  - Bridger Photonics Ltd. LiDAR technology
- 167 oil and gas site locations (yellow) in Northern BC, Canada
- EERL deployed wind sensors (flag) and tracer releases (star)
- Wide range of infrastructure
  - Isolated wells, single & multi-well batteries, compressor stations, and gas plants

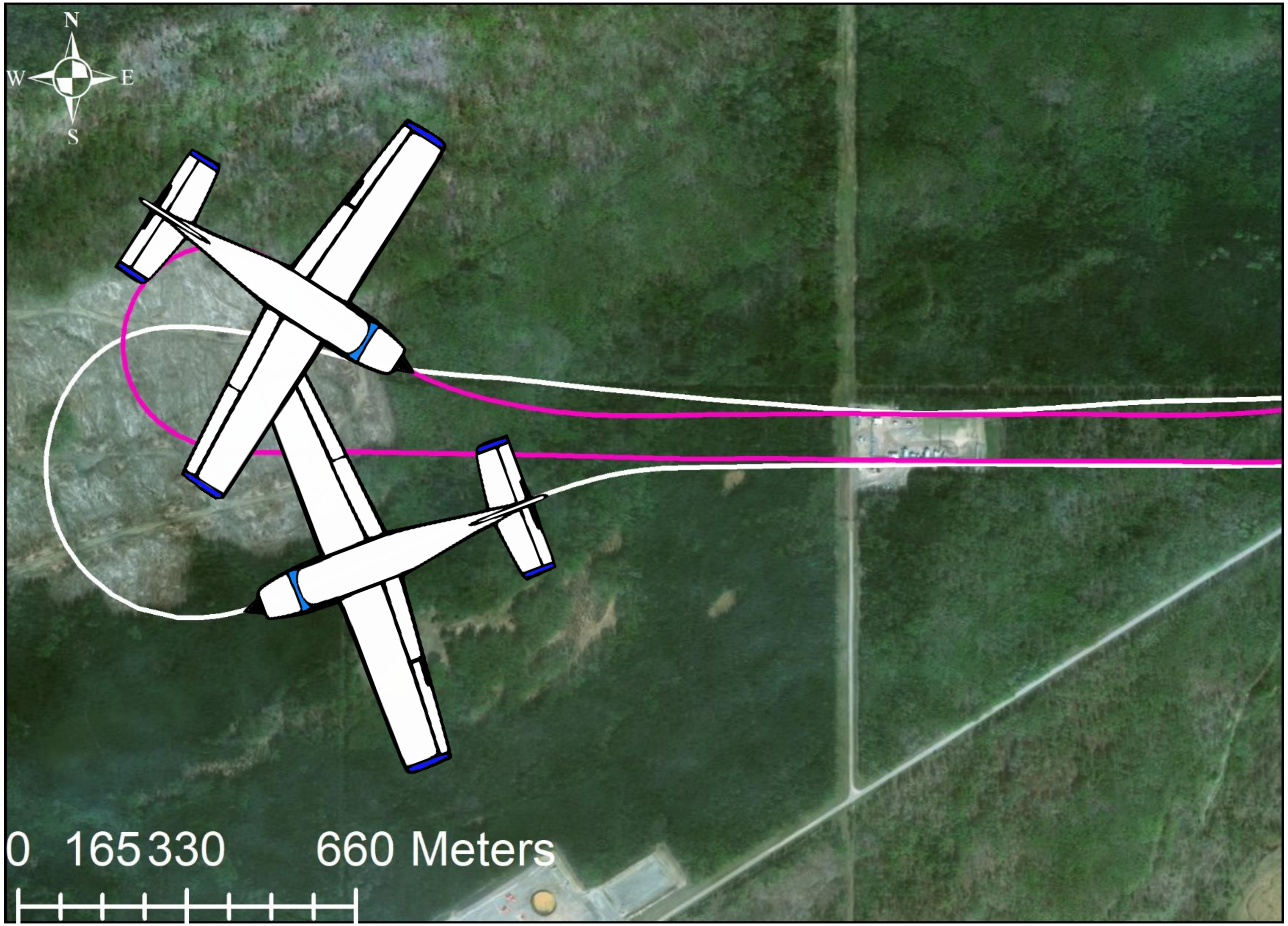


EERL Field measurement support

- Planning + on the ground field measurement support
  - Deployed wind sensors and *blinded* controlled releases
  - Enabled assessment of detection limits, quantification uncertainty, probability of detection
- Data analytics to interpret field measurement results
  - Comprehensive data processing to identify and quantify sources from multi-pass flight data
  - Comparisons with ground survey data

Aerial Methane Measurement Survey Overview

- Sites have one or more passes on first flight
  - LiDAR system scans site for methane emissions
  - Camera provides high resolution site imagery
- Sites with detected emissions had Reflights
- Quantified emission geo-located on each pass



Aerial Methane Measurement Technology Overview

- Assembled plume and quantified emission data provide a site level methane assessment
- Advances mitigation
  - Pin-points and quantifies emissions from sources (e.g. tanks, unlit flares) that are not quantifiable with current OGI
- Improves methane inventories
  - Large scale direct repeated measurement of oil and gas sites at less than half the cost of OGI
- Enables quantification of regulatory impacts

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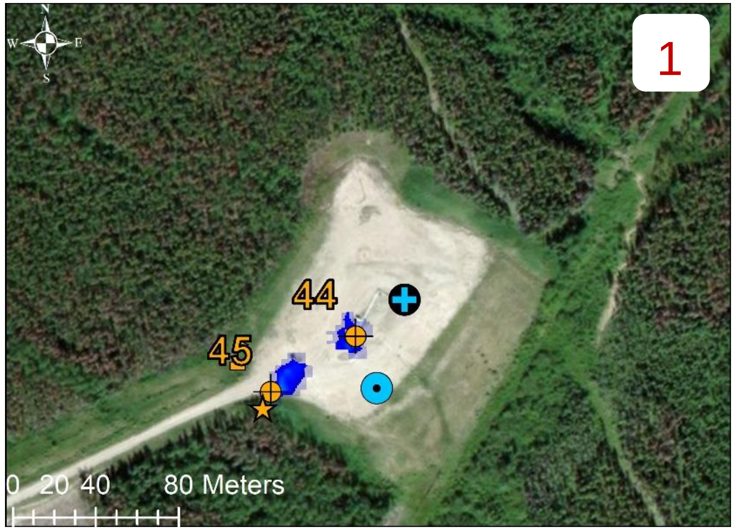
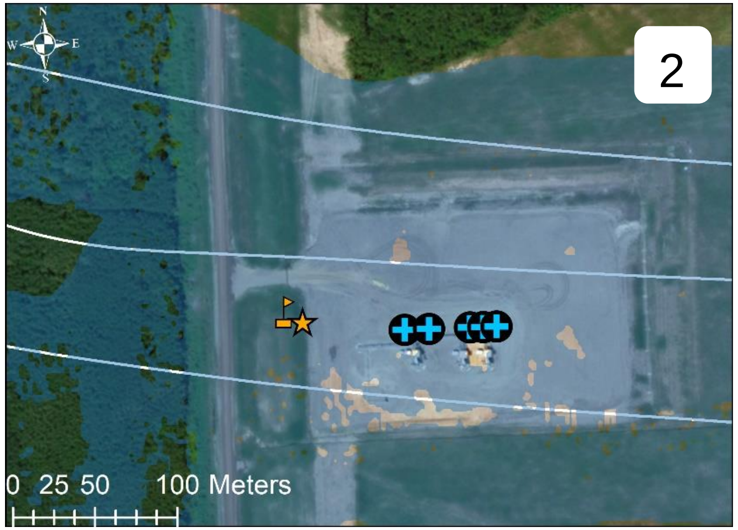
Deployment of (Mobile) Wind Sensors and Tracer Releases

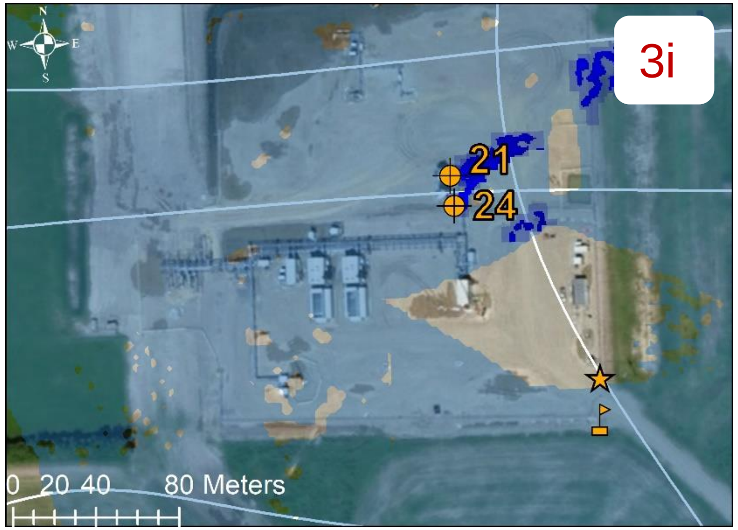
- Team of 8 (5 trucks) deployed Sept 16-20th
- Visited 48 unique sites over 5 flight areas
  - 65 wind measurements
  - 29 blinded tracer releases

Tracer Release Data: Detects, Zero Detects, and Misses

1. Detects
   - Bridger finds tracer release
2. Zero Detects
   - Release in laser swath but not detected
3. Misses/other:
   i. Release not in laser swath
   ii. Release seen but not quantified
   iii. Tracer plume not separable from other emissions

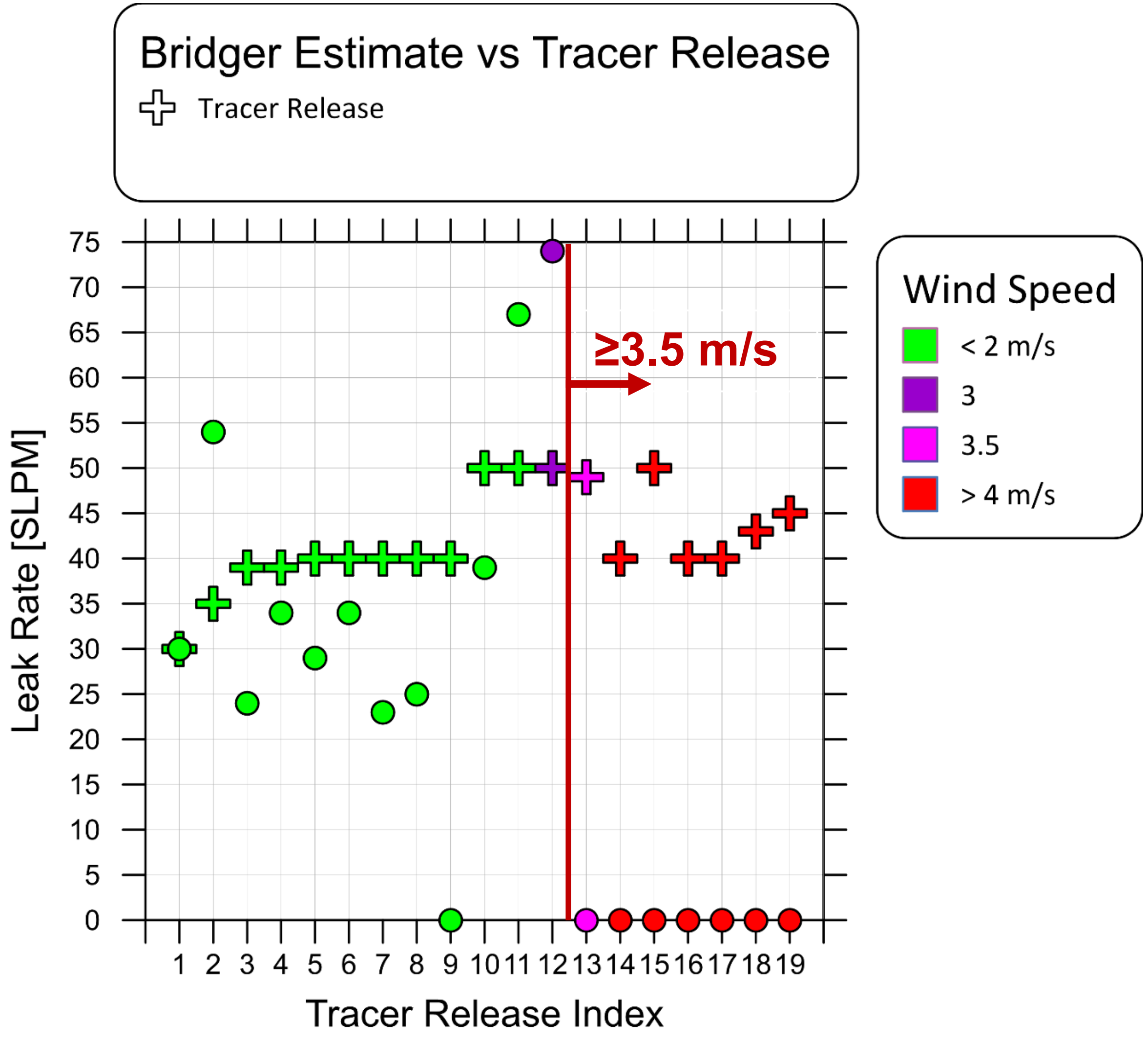






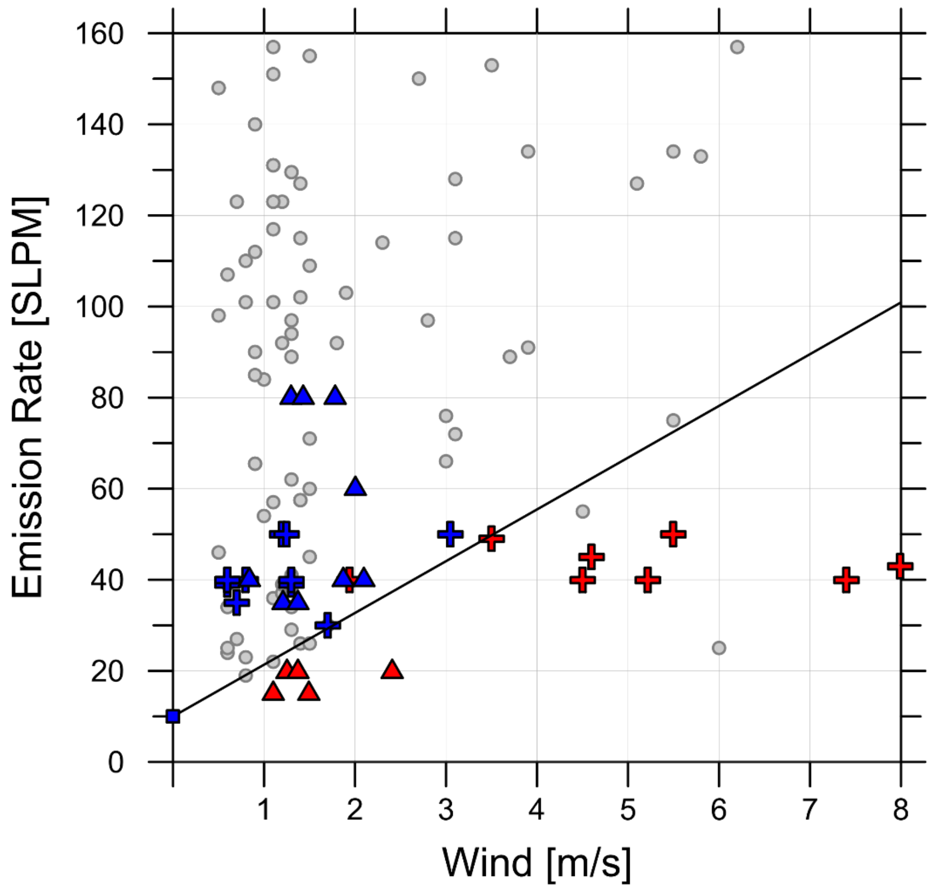
Bridger Tracer Release Estimates

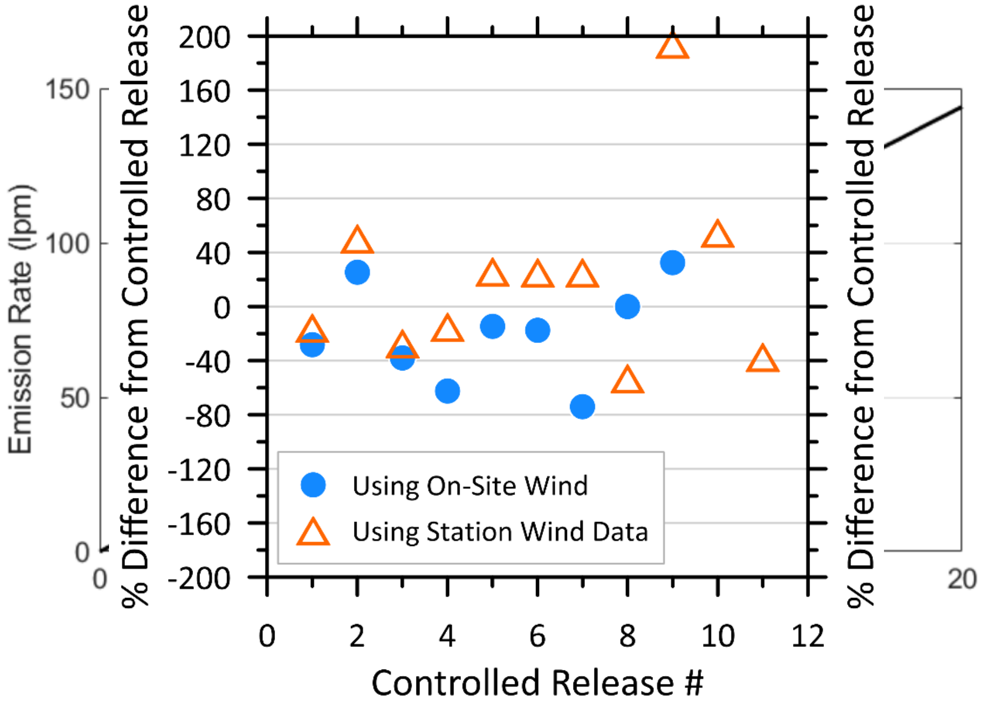
- 29 Tracer Releases
- 11 Bridger Detects
- 8 Bridger Zero Detects
- 10 misses/other
  - 3 mixed with other sources
  - 2 detected but not quantified by Bridger
  - 4 on edge of laser scan
  - 1 due to data loss
- Detection sensitive to wind speed



Preliminary Bridger Sensitivity for BC Measurements

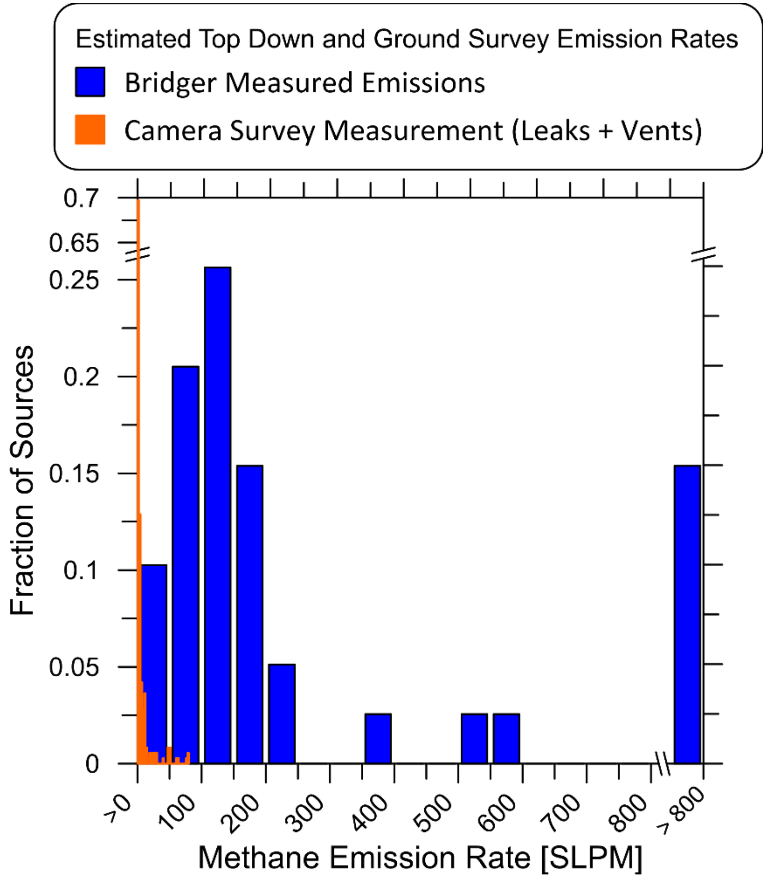
- Carleton Tracer Data combined with Bridger Data (presented at MERF, 2018)
- Lower Detection limit (slpm) ≈ 11.4 × Wind (m/s) + 10

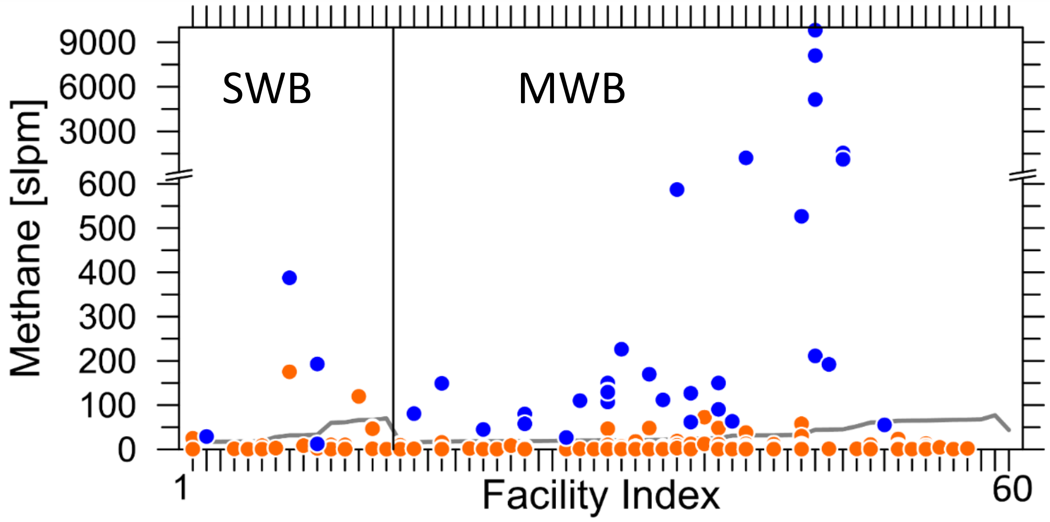


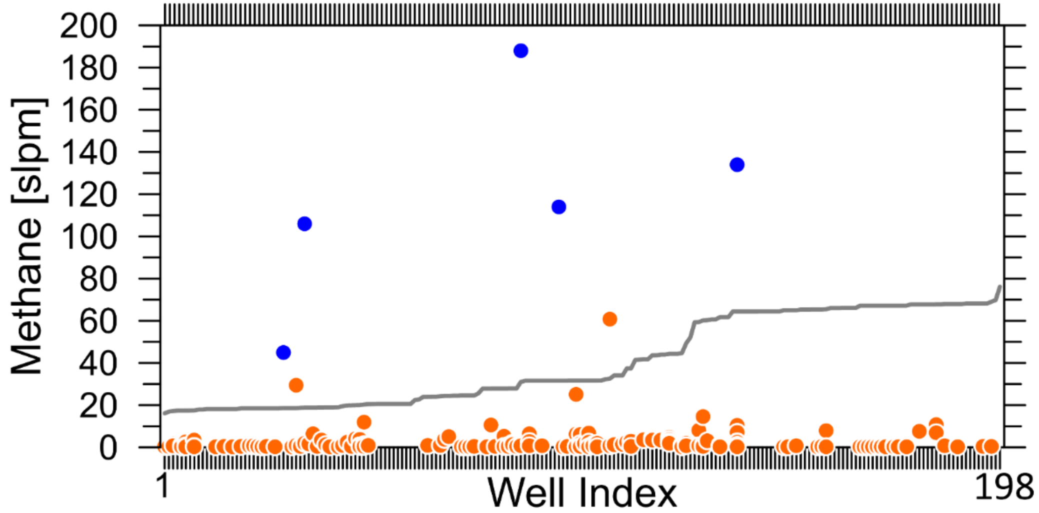


Different Scale of Detected Sources than OGI Camera Surveys

- Comparison of detected sources with OGI camera survey data from one year prior at the same sites







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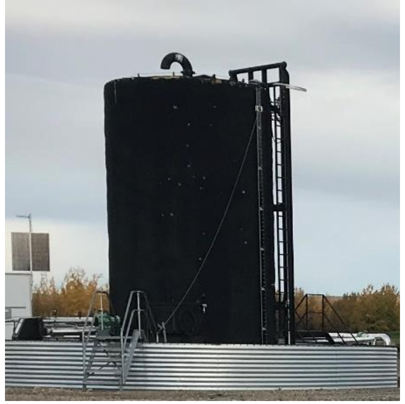
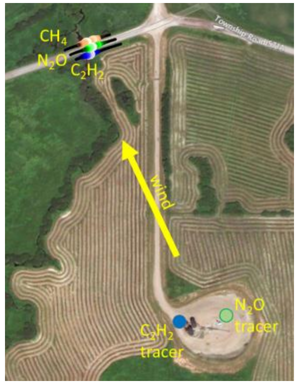
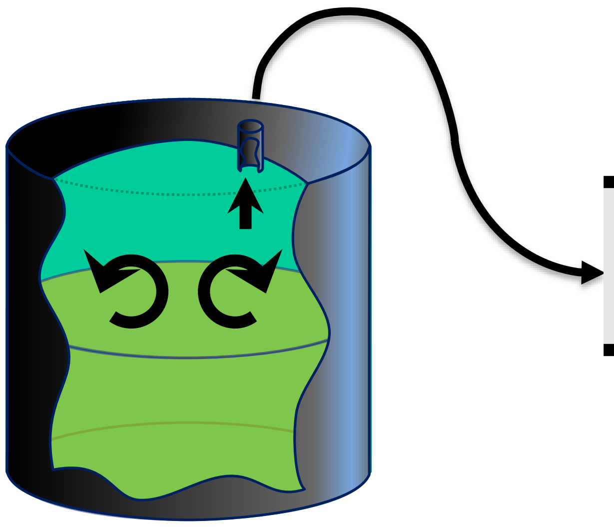
3. Equipment-Level Quantification of Key Sources (Tanks and Vents)

- Field measurements continue to implicate certain key sources:
  - Casing gas vents (especially intentional venting as in heavy oil production)
  - Storage tanks
- Both sources are difficult to quantify
- **Key issue in methane emissions management**
  - Tanks can often be the exit point for emissions from malfunctioning equipment
  - Lyon et al., EST, 2016:
    - Helicopter IR camera survey of 8220 sites
    - 90% of observed emissions from tanks
  - Roscolli et al., JAWA, 2018
    - Dual tracer measurements at a cold heavy oil production site
    - 77% of methane from Casing vent / 23% from tank

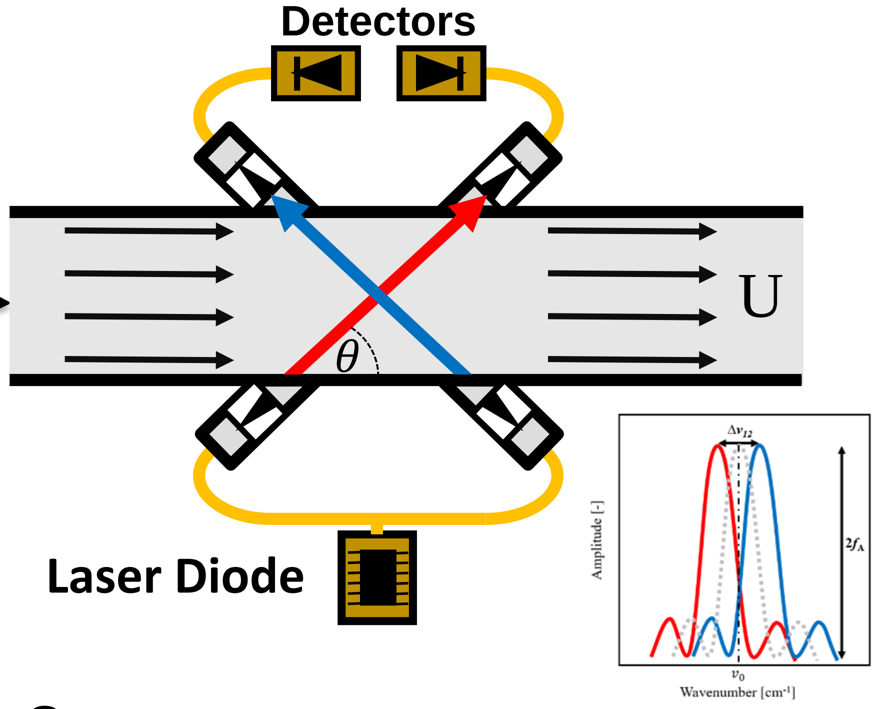




VentX – Direct Optical Quantification of Methane FLUX



Vent Source such as a Casing Gas Vent or Storage Tank



- **Methane-selective** measurement of concentration + velocity
- **DIRECT OPTICAL MEASUREMENT OF METHANE FLUX !**
- VentX measurement head deployable in Zone 0/1

Outputs:

- Methane Emissions (e.g. kg/s or m^3/s);
- Methane concentration (%)
- Flow velocity (m/s), Temperature, and Pressure
- Total vent volume flow rate (m^3/s)

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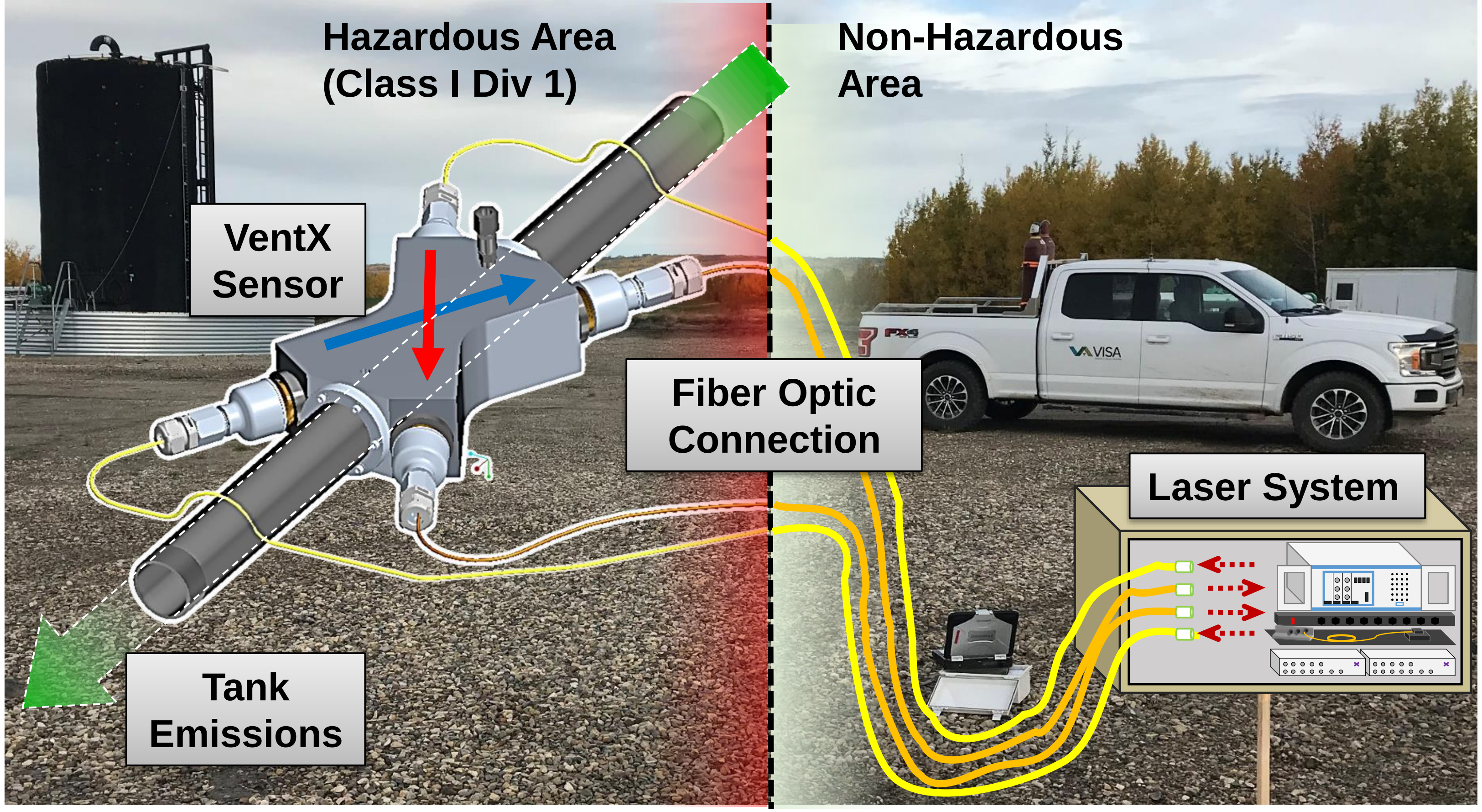
VentX Optical Methane Flux Measurement Technology

- Real-time monitoring and quantification of tank methane emissions
  - Intrinsically safe optical measurement of methane **flux**
- Technology development enabled by Natural Resources Canada (NRCan)
  - Clean Growth Program in partnership with INO and Husky Energy Ltd
- **Field testing Summer 2020**



Natural Resources Canada

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INO

Husky Energy

Conclusions

- Methane quantification and mitigation is a multi-scale problem
  - Aggregate measurements vital for tracking reductions and informing policy
  - Site-level measurements needed to monitor compliance with regulations and screen for mitigation opportunities
  - Key components (e.g. tanks and casing vents) must be measured to drive actual on-the-ground mitigation actions
- New technologies are making all of these goals possible
  - Critical that uncertainties and sensitivities are openly and objectively addressed
  - Sensitivities must align with regulatory limits to be most useful
- Proving equivalency of methods remains as an evolving and critical research challenge

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- C.A. Brereton, M.R. Johnson (2012) Identifying Sources of Fugitive Emissions in Industrial Facilities using Trajectory Statistical Methods, *Atmospheric Environment*, 51:46-55. (doi:10.1016/j.atmosenv.2012.01.057)

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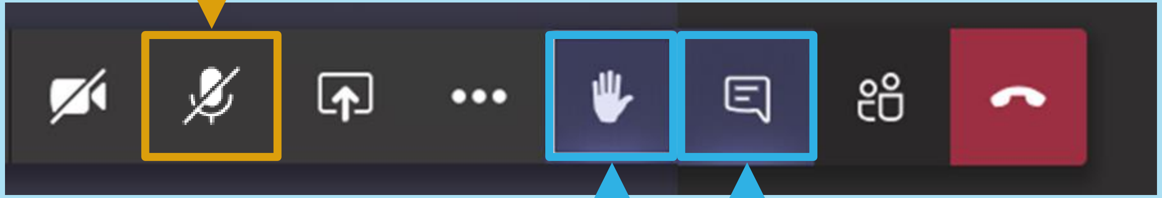
Question and Answer

Mute your microphone.

- Everyone should set the microphone to mute unless actively speaking.
- If participating by phone, press *6 to mute your phone.



If available, use the "Raise your hand" button to be called upon to speak.

Or, enter questions using the "Chat" pane. Type "Raise My Hand" to be called upon to speak.

Help!

Need Help?

If you need help, please send an email to asg@globalmethane.org

GMI Secretariat News and Updates

- Executive Task Force: In response to postponing the Global Methane Forum 2020, the Secretariat created the Executive Task Force to:
  - Facilitate discussion and decision-making
  - Engage a broader cross-section of the GMI community beyond Steering Committee members
  - Gather information and make recommendations to the Steering Committee
- 2020 Priorities:
  - Conduct webinar series for the Oil & Gas, Coal, and Biogas Subcommittees
  - Strengthen relationships with Partner organizations
  - Promote new tools and resources
  - Spotlight successful methane mitigation stories

Discussion Topics:

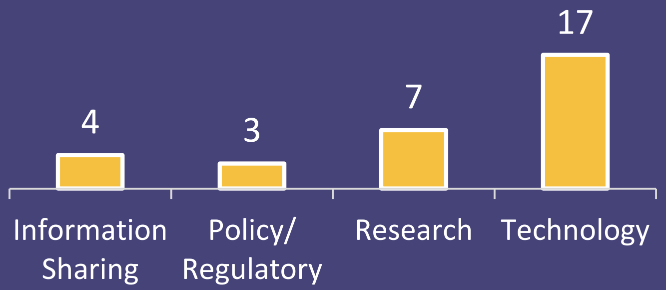
- GMI's Strategic Partners: How to Complement and Leverage Action
- The Global Methane Challenge
- Proposal for United Nations International Year of Methane
- Future of GMI

GMI Secretariat News and Updates

70 Stories from 23 Countries

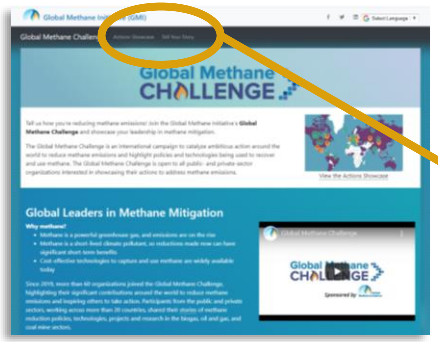
-- including --

31 Oil & Gas Stories



Global Methane CHALLENGE

- The Global Methane Challenge is still open!
- Launched in 2019 to raise awareness and catalyze ambitious action to reduce methane emissions

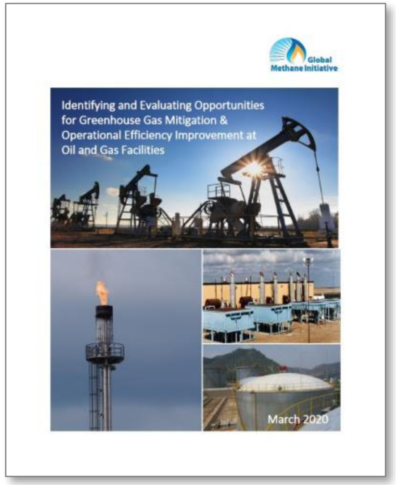


Submit your story at globalmethane.org/challenge/

Global Methane Initiative

GMI Oil & Gas Subcommittee News and Updates

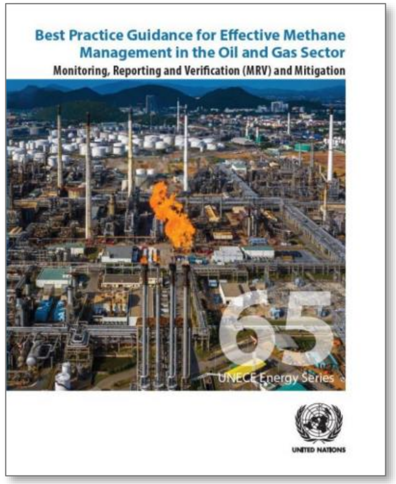
New Resources



GMI

Identifying and Evaluating Opportunities for Greenhouse Gas Mitigation & Operational Efficiency Improvement at Oil and Gas Facilities

Available in English, Spanish, & Russian; French will be available soon



UNECE

Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector: Monitoring, Reporting and Verification (MRV) and Mitigation

Global Methane Initiative

Wrap Up

Today’s presentation will be posted on the GMI event page

- Plans are underway for the next webinar, tentatively scheduled for late July or early August:

Drivers to Methane Mitigation, Focus on Policy

Reminder

We welcome your feedback!
We encourage you to share suggestions for future webinar topics by emailing us at asg@globalmethane.org

Global Methane Forum 2020 Agenda

- [x] Seeing Methane, the Invisible Problem …Who is Using Which Number?
- [ ] **Drivers to Methane Mitigation, Focus on Policy**
- [ ] Case Studies: Successful Emission Reduction Projects
- [ ] Global Carbon Offset Programs in the Oil & Gas Sector

Thank you for participating today

Global Methane Initiative

See you at the next webinar!