PTAC
PETROLEUM TECHNOLOGY ALLIANCE CANADA

# Area Methane Detection Using Work Trucks

**Final Report**
**June 19, 2019**

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**Executive Summary**

This final report summarizes outcomes for the Area Methane Detection Using Work Trucks project undertaken by Petroleum Technology Alliance Canada (PTAC) in collaboration with mAIRsure and Encana Corporation. This project commenced on November 1, 2016 and concluded on March 31, 2018.

The project demonstrated a near commercial (TRL 6 – 8) clean technology for the detection and monitoring of methane emissions in the upstream oil and gas (UOG) sector in support of the Canadian Government's policy to reduce methane and VOC emissions between 40% - 45% by 2025. The project consisted of two phases: (1) Field Demonstration of Advanced Sensors and Analytics Mounted on Work Trucks; and (2) Project Management and Reporting.

The objectives of this project were to (1) demonstrate clean technologies, (2) demonstrate technologies for methane detection and measurement, (3) disseminate project achievements. The project fulfilled these objectives through the following achievements:

- The primary objective of the field study (Task 1.5) was to provide emissions data on oil and gas sites. The project effectively obtained a valuable dataset of emissions across multiple, disparate sites, while also providing firsthand experience of operations with the mAIRsure system.
- With respect to Task 1.5, the techno-economic analysis indicates the Return of Investment (ROI) for this project is less expensive than adherence to existing reporting protocols with greater frequency of coverage (approximately $200-500 per annum per site).
- The aim of the controlled release tests (Task 1.4) were to validate the full sensor system's ability to accurately and quantitatively detect leaks of different sizes. Data analysis from these tests provide an initial verification of the full leak detection system.

# 1 Introduction

Canadian Upstream Oil and Gas (UOG) regulators and operators need cost-effective and accurate measurement and emissions monitoring technologies to build a reliable emissions baseline on operational sites enabling operators and regulators to focus resources on areas that vent the most methane. Work truck sensors for methane detection are a recent innovative approach that is gaining traction. mAIRsure has developed an innovative sensor as a service for this purpose, comprised of a laser instrument for point measurements of methane concentration along with analytics to determine leak locations and magnitudes (using methane concentration, meteorological, and geospatial data). The key enabling element of this system is a novel open-path cavity ring-down spectroscopy (CRDS) sensor allowing sensitive methane detection in a package that is far more compact, lightweight, and low power relative to the state-of-the-art. The deployment model for this technology was to install the compact sensor system on service trucks, with low incremental cost to operators, to provide high-throughput basin-wide

monitoring. The overall goal of the proposed was to demonstrate feasibility that this system will be able to provide reliable, accurate, and cost-effective leak monitoring when applied in realistic Canadian oil and gas field conditions. The project work plan consisted of the following:

- Conducting a field trial with three sensors on three of Encana's exiting work trucks. The trucks will be dispatched for their regular daily work in the field and no operator involvement from Encana personnel will be required. The sensor is fully self-contained.
- Conducting controlled release studies. The project will perform a short study of setting up a controlled methane release in appropriate outdoor location and sampling and analyzing it with the truck mounted sensor system. Data will be analyzed to prove ability accurately and quantitatively detect leaks of different sizes.
- Validating detected leaks against traditional measurements. Leaks detected by the mAIRsure sensor system will be independently measured using Optical Gas Imaging (OGI) equipment by mAIRsure (plus as appropriate an Encana representative) in a manner that is consistent with Canadian requirements and best practices for Leak Detection and Repair (LDAR). This activity could be extended to a double-blind test depending on facility availability.
- Developing reporting protocols. Using geo-spatial position information, meteorological information, and outputs from the Azure algorithms, the project will develop reporting protocols showing maps of leaks detected (with confidence), area covered (and not covered) and separate tabulations of leak information. These reports will be discussed with industry partners for their feedback. The goal will be to set a path towards reliable field wide coverage, encompassing both wells and facilities, offering potential leak identification where it is currently not deemed to be cost effective.
- Conducting a Techno-Economic Analysis (TEA). The existing scheduled LDAR protocol will be compared against the work truck "sensor as a service" approach to determine "time saved in leak detection" and "reducing cost of finding emissions". Overall cost effectiveness to be assessed in comparison to traditional OGI methods.

The project team comprises Encana, a senior Canadian oil and gas producer, and mAIRsure, a company dedicated to methane leak detection, along with academic partner Colorado State University (CSU), who have developed the sensor and will contribute expertise in leak detection and analysis including meteorological and algorithm modeling.

**Phase1. Field Demonstration of Advanced Sensors and Analytics Mounted on Work Trucks**

Management direction and control of the project will reside with mAIRsure LLC. Professor Azer Yalin (CSU) served as the overall project principal investigator and technical lead. Yalin is a leader in trace gas detection and cavity ring-down spectroscopy laser diagnostics. The CSU team further comprised Prof. Jay Ham, an expert in methane emissions and sensor instrumentation, and Prof. Jeff Peirce an expert in atmospheric plume modeling. The CSU team leveraged experience from Yalin's research group in sensor deployments based on designs from the Earth System Research Laboratory of the National Oceanic and Atmospheric Administration (NOAA). Much of the work plan was based on ongoing development of an approved work process with the

input of the US Environmental Protection Agency (EPA)'s R&D division. Roles of partners are summarized as follows:

- Regulator Involvement: To monitor and approve plan protocol-the objective is to ensure regulators "signoff" so approval as an Alternative Work Practice (AWP)is obtained.
- Encana: Demonstration site provider
- mAIRsure and academic partner CSU: Day-to-day operations/ academic rigidity of data. Specific tasks are listed:

*Task 1.1. Kickoff Meeting (Month 1)*
A review of regulator's goals for AWP approval was conducted, as it relates to applicable regulations to delineate project and measurement priorities.

*Task 1.2. Preparatory Work Prior to Field Trial (Month 1-4)*
A basic simulation was performed of anticipated coverage of Encana's selected field based on allowable emissions, size and geography of field, driving patterns and dispatch routes, and historical meteorological patterns.

*Task 1.3. Vehicle Mounting in Alberta (Month 4-5)*
This task comprised mounting our sensor to mobile platforms for sensor testing, including both on mAIRsure's own vehicle and Encana's vehicles. In all cases, minimum or zero disruption to the normal use of Encana's work trucks, workflows, as well as, driver and crew was prioritized.

*Task 1.4. Controlled Release Studies in Field Setting in Alberta (Month 5-8)*
We performed controlled release experiments, using CSU hardware, to demonstrate and validate sensor accuracy and sensitivity as a function of leak size, distance from leak to truck, and sensor meteorological conditions (wind speed, steadiness, and direction). These studies also informed the sensor maintenance and calibration interval, as well as illustrate the validity of test results in real conditions.

*Task 1.5. Field Study of Natural Gas Infrastructure (Month 5-8)*
We conducted a field study to characterize the performance of the sensor and our analysis methods for real natural gas infrastructure. The study was conducted in Encana's Alberta field.

*Task 1.6. Leak Quantification Algorithms (Month 1-8)*
Data analysis included a detailed comparison of concentrations measured (accuracy, dynamic response, background drift, etc.) under a wide range of meteorological conditions (atmospheric stability classes, wind speeds, etc.) and deployment scenarios. This activity leveraged expertise from Dr. Hamand Pierce from CSU using algorithms including both statistical approaches and filament-based dispersion models. We examined the robustness of combining drive-by data from multiple days to improve quantification of both leak location and magnitude, as well as the use of (lower time resolution) wind measurements from public sources (NOAA databases) in place of detailed local measurements.

*Task 1.7. Software and Development of Customer Reports–Microsoft Azure Partnership (Month 1-8)*

Ongoing activities included: (1) Database refinement; (2) Algorithm development, including plume modeling, weather database inquiries; (3) Machine learning development; and (4) GIS interface.

*Task 1.8. Techno-Economic Analysis (TEA) (Month 7-8)*

Based on measurement results, simulations (Task 2), and financial data (i.e. sensor service cost etc.) we have performed a TEA to examine costs, and cost trajectories, of the service truck approach including metrics of time saved in leak detection and cost per sensor per site.

*Task 1.9. Project Final Report (Month 9)*

We have written and compiled the findings and data in a report for project sponsors. A similar report was used as part of the process of seeking AWP from Canadian and US regulators. Comparison to Canadian Federal and Alberta provincial regulatory requirement was included as well.


**Figures 1 and 2. Sensors mounted on the roof of Encana's vehicles**

**Phase 2. Project Management and Reporting**

*Task 2.1. Facilitation and Technical Support*
PTAC provided project management services for the project. PTAC has disseminated project information at quarterly Technology for Emissions Reduction and Eco-Efficiency (TEREE) Committee meetings and has extended the invitation to mAIRsure to share project results at future PTAC events with oil and gas producers following project completion, to allow for dissemination of technologies and findings.

*Task 2.2. Final Reporting*
PTAC has assembled the final reports and will submit them for approval of project completion.

# 2 Background

As stated above, the purpose of the Project was to demonstrate a near-commercial (TRL 6 to 8) clean technology for the detection and monitoring of methane emissions in the UOG sector in support of the Canadian Government policy to reduce such emissions by 40 to 45% by 2025. In 2011, Canadian GHG emissions for upstream oil and gas flaring, methane venting and fugitives were 34.4 million tonnes $CO^2e$. Direct methane emissions account for 89% of this amount and are primarily composed of:

- Fugitives (33%) which are primarily composed of16% from SCVF which are leaks from wellbores; 11% from equipment leaks; and 6% from other sources;
- Reported venting (30%) which are the amounts reported to regulators from production accounting systems and are mostly composed of well casing vents in cold heavy oil;
- Unreported venting (26%) which are composed of many small releases from pneumatic equipment and other process sources.

The first challenge to meet the goal of 40-45% reduction by 2025 is to accurately account for the baseline of emissions using reliable measurement techniques. Emissions measurement in the UOG sector does not currently occur with the accuracy and granularity required for compliance and assessment of fees or taxes. Specifically, this proposal aims to address leak detection and repair (LDAR) by demonstrating that the mAIRsure sensor technology can provide cost effective and precise leak detection measurement to help Encana identify and repair leaks on their sites. While the emitting sources are known, there are over 100,000 sources and a central inventory does not exist. Furthermore, many sources emit small intermittent volumes at low pressures. Measurement precision is challenged by the temporal irregularity of the flow and the fact that mechanical instrumentation will apply back pressure. Establishing the baseline will require massive resources unless faster and scalable technologies are deployed. The proposed project, Area Methane Detection using Work Trucks, included a demonstration, field testing and validation by mAIRsure and Encana of an advanced proprietary methane detection technology used to cost effectively identify and measure methane emissions from Encana facilities spanning a wide area. It conducted field trials in Alberta to demonstrate the benefits of a work truck

mounted sensor detection system. mAIRsure and Encana employed new open-path laser ring-down sensors developed at CSU and data from the trucks was fed to the Microsoft Azure cloud computing platform for processing and identification of leaks.

# 3 Objectives

Methane emissions from the Canadian UOG sector originate predominantly from Alberta and Saskatchewan, and from light/medium and heavy oil production, natural gas production and SCVF. Thermal heavy oil production, such as the oil sands, only contributes 1%to methane emissions.

## *3.1 Demonstrate Clean Energy Technologies*

- To demonstrate clean energy technologies that will enable real reduction in methane emissions in the UOG sector focusing on the major sources, namely cold light/medium and heavy oil production, natural gas production, and SCVF in Alberta and Saskatchewan.
- The emissions dataset obtained during Task 1.5 contributed to achieving this objective by providing emissions data that can be used to enable methane emissions reductions.

## *3.2 Demonstrate Technologies for Methane Detection and Measurement*

- To demonstrate reliable, scalable, rapidly deployable and effective (with respect to human and financial resources) technologies for methane detection and measurement using novel remote sensing sensors, platforms and analytics.

## *3.3 Disseminate Project Achievements*

- To broadly and collaboratively disseminate project achievements and learnings in order to accelerate industry's trajectory to delivering on the policy goal of 45% reductions by 2025.
- Technologies and findings from the field trial were disseminated amongst oil and gas producers at various TEREE committee meetings hosted by PTAC, which took place on Tuesday, December 11, 2018 and Tuesday, March 12, 2019. Additionally, on October 19 and December 7, 2017, PTAC held two invitation-only workshops focused on methane emissions reduction technologies. Ongoing work was disseminated to attendees.

# 4 Project Results

## *4.1 Project Achievements*

### 4.1.1 Achievement 1

The primary objective of the field study (Task 1.5) was to provide emissions data on Encana's individual sites. The project effectively obtained a valuable dataset of emissions across multiple,

disparate sites, while also providing firsthand experience of operations with the mAIRsure system.

#### 4.1.2 Achievement 2

With respect to Task 1.5, the techno-economic analysis indicates the ROI for this project is less expensive than adherence to existing reporting protocols with greater frequency of coverage (approximately $200-500 per annum per site).

#### 4.1.3 Achievement 3

The aim of the controlled release tests (Task 1.4) were to validate the full sensor system's ability to accurately and quantitatively detect leaks of different sizes. Data analysis from these tests provide an initial verification of the full leak detection system.

### *4.2 Project Challenges*

#### 4.2.1 Challenge 1

With respect to Task 1.5, there were issues with deploying staff to the test region and adverse field conditions. These factors limited data collection; however, some example readings of elevated methane plumes were obtained.

## 5 Conclusion & Follow-Up

The overall objective of this project was to demonstrate clean energy technologies that will enable methane emissions reductions in the oil and gas sector; to demonstrate reliable, scalable, rapidly deployable and effective technologies for methane detection via remote sensing sensors, etc.; as well as, to disseminate project achievements and learnings within industry. While project work has been completed with the aim of meeting these objectives, future works remains. Additionally, technology and findings from the field trial were disseminated amongst oil and gas producers at various committee meetings hosted by PTAC.

### *5.1 Next Steps*

Per NRCan reporting guidelines, PTAC will be contacting all partners involved in the project every year for five-years to request performance statistics and further updates.