



PTAC

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TECHNOLOGY
ALLIANCE
CANADA**

PTAC Methane Detection and Mitigation Initiatives Report

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Executive Summary

This report outlines various methane detection technologies including, spectrometers, laser-based sensors carried by light airplanes, drones and super sensitive stationary sensors and cameras, which have been used by PTAC consortia to collect a tsunami of methane emissions data. By developing statistical, and simulation models, PTAC is helping producers to gain insight of the trends in methane emissions from various sources, optimizing the implementation of new technologies in fugitive emissions management programs to achieve mitigation targets at the lowest cost, and guiding technology development and commercialization.

In addition, this report outlines the numerous technologies developed, field tested, and demonstrated through PTAC's consortia, which collectively have the capacity to reduce the sector's methane emissions by more than 45%.

These technologies are not only currently reducing methane emission in Canada but also are helping global reduction of methane emissions.

Methane emissions reduction is the fastest, most cost-effective approach in reducing GHG emissions. The Carbon Capture and Sequestration (CCS) cost of reducing CO₂ starts at \$50/tonne and can increase to over \$170/tonne. Conversely, the cost of reducing methane emissions starts at a negative cost and increases to significantly below \$50/tonne of CO₂ equivalent. Methane, unlike CO₂, has commercial value; we can sell methane.

Methane is the key to creating a clean Canadian oil and gas brand. Methane emissions reduction allows more natural gas to be sold for profit while simultaneously improving our environment. Methane is the catalyst where traditional oil and gas and leading-edge cleantech meet. It has the potential to forever change how we do business by helping Canadian small- and medium-sized cleantech companies prosper nationally and internationally.

Natural gas is, and will continue to, play an important role in the energy system for many years to come; particularly with the future of electrification supporting the energy evolution for electricity generation with lower-carbon footprints. The International Energy Agency (IEA) is forecasting that electricity generation from natural gas will increase by over 25% by 2050. Using methane reforming technology, combined with carbon capture, utilization, and storage (CCUS), enables us to generate hydrogen from natural gas to provide clean transportation fuel at near zero emissions. Work is also in progress for cold conversion of methane to hydrogen at near zero emissions.

Electricity generation with the lowest carbon footprints from the combustion of natural gas and CCUS, or hydrogen generated from the above technologies, are essential for

achieving net zero by 2050, provided that we significantly reduce methane emissions from production, processing, and transportation of natural gas. Canada can play a major global leadership role in using methane to generate clean electricity or transportation because we are the global leader in CCUS, hydrogen, and methane detection/mitigation technologies.

Throughout its 25 years of operations, PTAC has made significant contributions to methane emissions reduction. PTAC's roles include formation of numerous methane detection and mitigation projects; the facilitation, coordination, and management of methane mitigation and detection applied research; and development, field testing, demonstration and deployment of technologies leading to building enough technology capacity to reduce the oil and gas sector's methane emissions by over 45%.

More than a decade ago, PTAC started working on initiatives to reduce methane emissions. The Methane Emission Reduction Network (MERN) was formed to be an innovation network with a vision to build methane detection, quantification, monitoring and mitigation technologies. MERN's short-term goal is to help build enough technology capacity to reduce 45% of 2012 methane emissions at a cost of less than \$5/tonne of CO₂ equivalent by 2022. The network works in collaboration with [Clean Resource Innovation Network](#) (CRIN), and [Canadian Emissions Reduction Innovation Network](#) (CERIN).

Our over 40 applied research projects have immensely helped oil and gas producers with the needed cost effective and accurate methane detection and mitigation best management practices. The projects also provided scientific and engineering facts to policy makers and regulatory bodies to develop their smart policies and regulations.

The PTAC Fugitive Emissions Management Program Effectiveness Assessment (FEMP EA) is a world class methane detection, quantification and verification applied research project. FEMP-EA has sought to address the gap in understanding the efficacy of LDAR surveys in addressing methane emissions. This work has created one of the largest comprehensive data sets of bottom-up methane emissions at oil and gas facilities across Canada and the U.S. Preliminary analysis is expanding insights on the sources and components most prone to exhibiting high emissions. The study area of 50 x 50 km was chosen based on the density and distribution of facilities in the Red Deer region of Alberta. Approximately 180 sites were surveyed at regular intervals between August 2018 and August 2019.

The Alberta Methane Field Challenge (AMFC) phases 1 and 2 were field campaigns conducted in 2019 to assess the performance of new methane leak detection and quantification technologies at producing oil and gas facilities. Two separate field trials were conducted in 2019, one in June and the other in November. Each of the field trials consisted of approximately two weeks of testing across 50 oil and gas producing sites near Rocky Mountain House, Alberta. The field trials tested five different types of leak detec-

tion methods: fixed continuous monitoring systems; handheld devices; truck-mounted sensors; drone-mounted sensors; and aerial systems. Overall, 12 technologies were field tested as part of AMFC.

In addition to the technologies field tested, five methane detection technologies were developed and 12 technologies were demonstrated/deployed through PTAC's programs.

PTAC's ultimate goal is to launch projects for development, field testing, demonstration, deployment, and market uptake of methane mitigation technologies to meet our short- and long-term goals of building technology capacity to have the capability of reducing methane emissions by 45% and 90% by 2022 and 2030, respectively.

Over the past 15 years, PTAC, through the National Research Council of Canada's Industrial Research Assistance (NRC/IRPA) Program, along with Alberta Innovates (AI), Natural Resources Canada (NRCan), and Emission Reduction Alberta (ERA), has secured funds to help small and medium-sized enterprises (SMEs) develop their technologies.

The nine Methane Mitigation Technologies Developed through PTAC collectively have capacity to reduce oil and gas sector's methane emissions by 37%.

The SMEs' technologies field tested through PTAC have addressed the SMEs' largest challenge: the valley of death. This refers to the significant challenge of moving early development stage technologies to a point where they can be commercialized. Numerous technologies have failed to move to the latter commercialization stages – hence “the valley of death.” An example of technology commercialized through the PTAC consortia is the REMVue technology, which captures methane and other light hydrocarbons to utilize as fuel for operations. This technology is currently reducing GHG emissions equal to taking 175,000 cars off the road while reducing industry cost by \$20 million. Even with this impressive performance, the uptake of this technology is low.

In 2017, PTAC decided it was time to take a more systematic approach to addressing the valley of death challenge so, a consortium of field testing facilities was formed, which is known as the Canadian Emissions Reduction Innovation Consortium (CanERIC). This consortium consists of 14 producers, and 16 universities & research centres in Canada and the United States who have dedicated their field and lab facilities, worth over a billion dollars, to CanERIC.

In essence, PTAC has created an impressive network of testing facilities, located from the East coast to the West coast. By securing funds from AI and NRCan, and with industry support, PTAC has been able to help SMEs field test their technologies at no cost to them. So far, three technologies have been lab tested, nine technologies have been developed and/or field tested, and six technologies are undergoing various tests.

The majority of the field-tested technologies are through consortia; however, the CanERIC facilities are currently conducting the majority of the field-testing. **The twenty-one**

Methane Mitigation Technologies Field Tested through PTAC collectively have the capacity to reduce oil and gas sector's methane emissions by 48%.

Even if a technology is field tested and proven to be cost-effective and reduce methane emissions, the SMEs still face the challenge of increasing the market uptake of that technology. To attempt to mitigate this challenge, PTAC launched two consortia that pay up to 75% of the cost of equipment and installation of cost-effective methane mitigation technologies, encouraging Canadian producers to get first-hand experience with the new technologies. These consortia aim to increase the investment in massive deployment of such technologies by producer, hence increasing market uptake.

Together they have resulted in installing 101 pieces of equipment, including 10 site electrifications, 37 pump optimizations, 26 smart pumps, 14 STD Electrics, 12 Instrument Air Compressors, one facility of the future, and one new compressor engine design.

These technologies collectively are reducing ~90,000 tonnes of methane emissions. It has been estimated that the upside potential in mass deployment of the identified technologies is at least 5,000 site electrifications, 5,000 pump optimizations, and 5,000 instrument air compressors, 10,000 smart chemical pumps, 10,000 STD Electric chemical pumps, and 500 compressor engines installed in oil and gas facilities in Canada. Using this estimate, the collective technology capacity of the above methane mitigation technologies developed, field tested, and demonstrated yield outcomes aligned with previous approaches in impact assessments.

The sixteen Methane Mitigation Technologies/Projects Deployed/Demonstrated through PTAC have the collective capacity to reduce oil and gas sector's methane emissions by 39%. To further increase the market uptake of SMEs' technologies, PTAC also created the [Canadian Capabilities in Methane Emissions Reduction Guide and Directory](#), listing over 59 Canadian cleantech companies looking to bring their methane technologies to international markets. PTAC's product-market-fit assessments help cleantech SMEs prosper. Last year alone PTAC completed 55 assessments with the financial help from NRCan/IRAP and supported the launch of 20 consortia to help SMEs achieve economic prosperity.

In the coming year, PTAC will launch several new initiatives to expand our international activities. This will include a strategic program to increase international sales of Canada's cleantech products and technologies. In closing, reducing methane emissions requires global collaboration. It is through this collaboration that PTAC has achieved so much.

In order to continue working towards PTAC's long term goal of increasing industry's technology capacity to reduce methane emissions by 90% by 2030, PTAC has brainstormed several new project ideas to implement in the near future. These initiatives will

continue to help reduce methane emissions while helping clean tech companies prosper:

- The continuation of funding for CanERIC;
- Expansion of the STV and MCP programs;
- Development of an Industry Certification to showcase operators who meet and exceed industry standards;
- In collaboration with distributors, regulators, and consumers, PTAC could develop and manage a certification or seal of approval process that will showcase those that meet and exceed industry GHG emissions standard.
- Creation of an Industry Needs App for technology providers, allowing them insight on producer needs; and
- Creation of a Technology App/Directory for producers, outlining available methane mitigation technologies.

In conclusion, reducing methane emissions is a low hanging fruit opportunity which we Canadians cannot afford to miss. There are many other countries that are catching up fast; however, we can maintain our competitive advantage through continued collaboration and strategic partnerships.

Introduction

Global Methane Emissions

The majority of global efforts to reduce GHG emissions have been focused on carbon dioxide. As methane is odourless and colourless, this greenhouse gas has remained out of sight, out of mind for many. Recently, however, various methane technologies including spectrometers, laser-based sensors carried by satellites, light airplane, drones and super sensitive stationary sensors and cameras have changed this perception.

For example, the analysis of satellite imagery data by KAYRROS indicates that the number of methane emission “hot spots” in oil and gas basins in the first 8 months of 2020 was 32% greater than the same period in 2019, and the majority of the emissions were coming from oil and gas operations in the Middle East, Russia, some African countries, and the US. In comparison, Canada’s methane emissions, as the fifth largest oil and gas producers in the world, are minimal.



Figure 1: Methane Technologies

Image Credit: PTAC

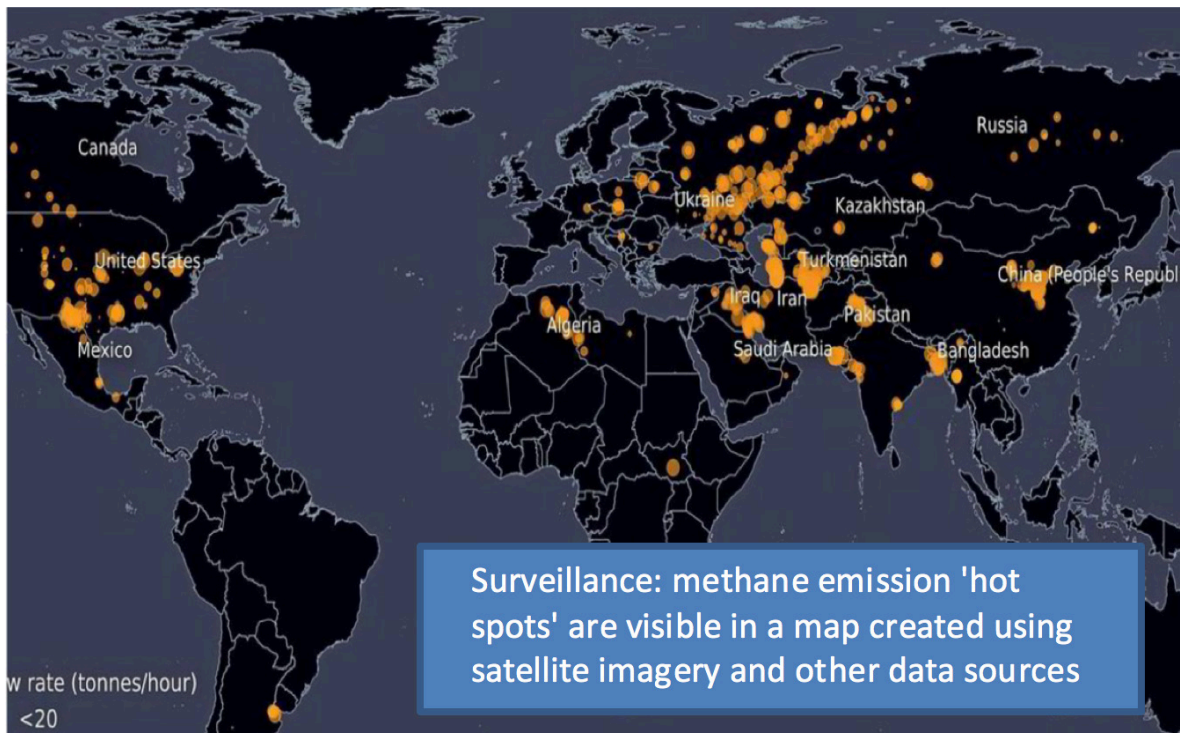


Figure 2: Methane Hot Spots

Image Credit: KAYRROS

Methane is the second largest greenhouse gas. The current annual global methane emissions are around 570 Mt, of which approximately 40% of the emissions are derived from natural sources (forest fires, and wetlands), 25% from agriculture, 23% from oil and gas, and the remainder from landfills.

Sources of methane emissions

Methane Tracker 2021

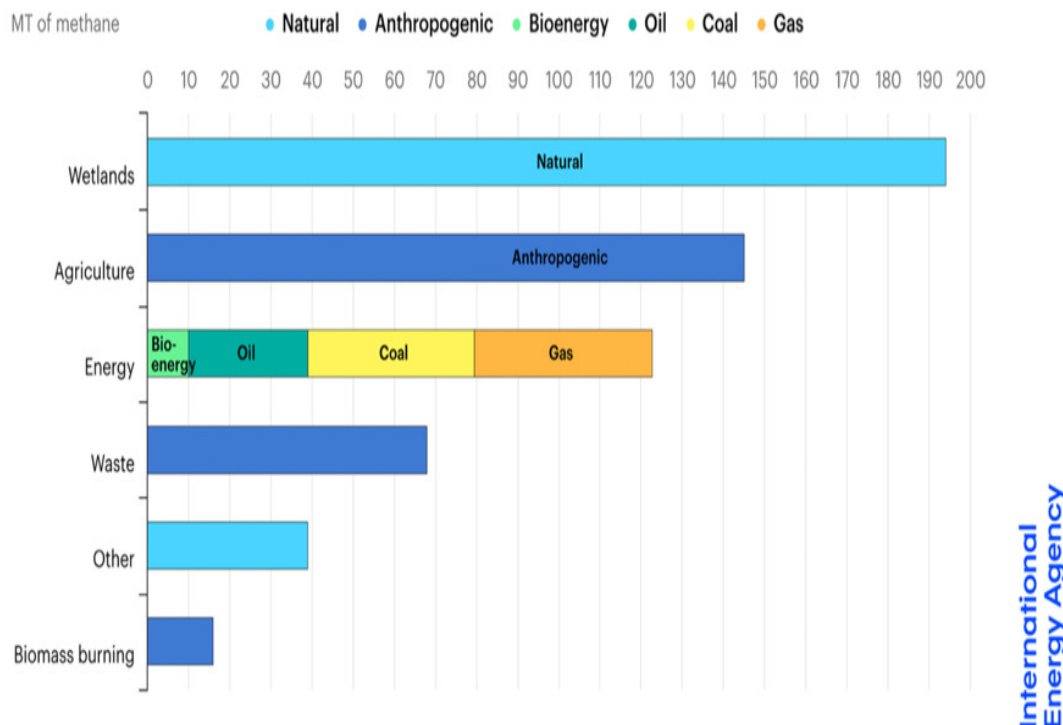


Figure 3: Sources of Methane Emissions

Image Credit: International Energy Agency

Impact of Greenhouse Gases (GHGs)

The impact of various GHGs is determined by the duration of time they remain in the atmosphere and their ability to absorb energy. Although methane has a much shorter lifespan than CO₂ (12 years in comparison to centuries), it is by far a more potent GHG. To estimate methane's effect on global warming, the most commonly used method is the Global Warming Potential (GWP). This method expresses a tonne of GHGs emitted in CO₂ equivalent terms to provide a single measure of the total GHG emissions.

The GWP method considers methane to be equivalent to 28-36 tonnes of CO₂, if looking at its impact over 100 years, and between 84-87 tonnes when it is considered over 20 years. The IPCC has stated that the next 10 years will be the most crucial in controlling climate change. During this short period, the global warming impact of methane will be approximately the same as CO₂.

Breakdown of Canada's GHG emissions in terms of CO₂e is shown in the picture below. Oil and gas emissions is 26% of Canada's total emissions.

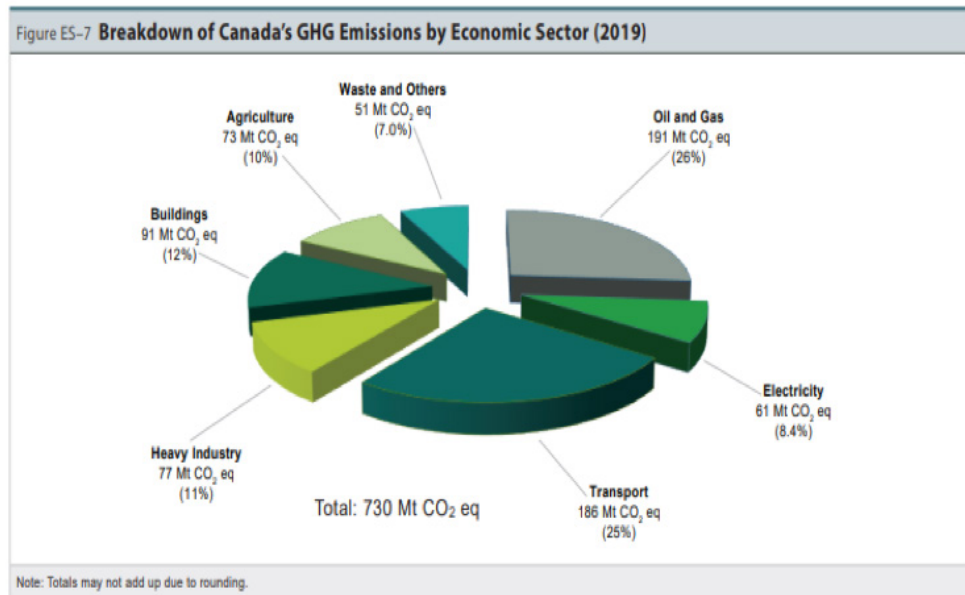


Figure 4: Breakdown of Canada's GHG Emissions by Economic Sector
Image credit: National Inventory Report 1990 – 2019: Greenhouse Gas Sources and Sinks in Canada

To further break down the 26% of GHG contributions the oil and gas sector contributes to Canada's emissions of various hydrocarbon types are shown here:

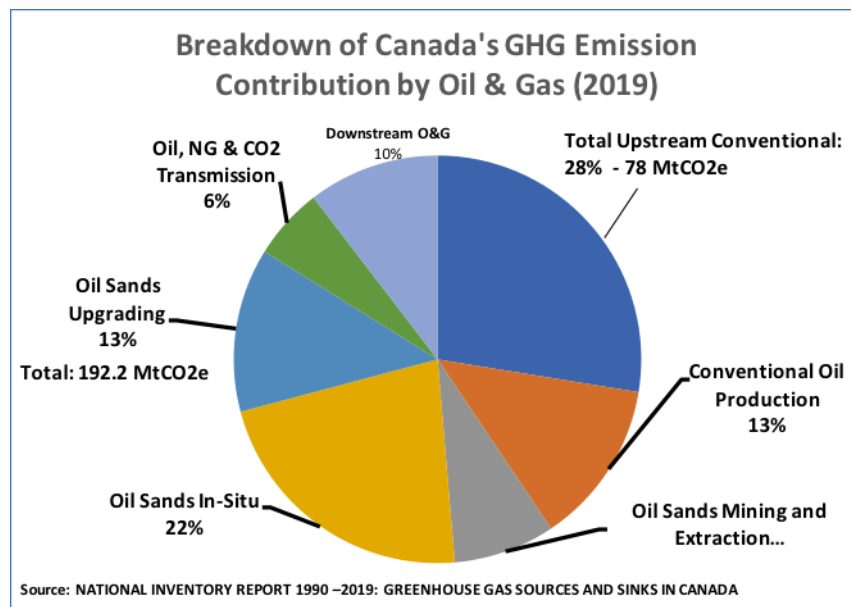


Figure 5: Breakdown of Canada's GHG Emission Contribution by Oil & Gas
Image credit: National Inventory Report 1990 – 2019: Greenhouse Gas Sources and Sinks in Canada

Methane is also associated with volatile organic compounds, or VOCs, and is an ingredient in the formation of ozone pocket. Hydrocarbons vented from oil and gas affects our environment, but also our health. This sounds daunting, but reducing methane

emissions provides tremendous health, environmental and economic benefits. Reducing methane emissions is a massive opportunity that Canadians cannot afford to miss.

Methane as a Method to Reduce GHGs

Methane is the key to creating a clean Canadian oil and gas brand. Methane reduction allows more natural gas to be sold for profit while simultaneously improving our environment. Methane is the catalyst where traditional oil and gas and leading-edge cleantech meet. It has the potential to forever change how we do business by helping small- and medium-sized cleantech companies proposer nationally and internationally.

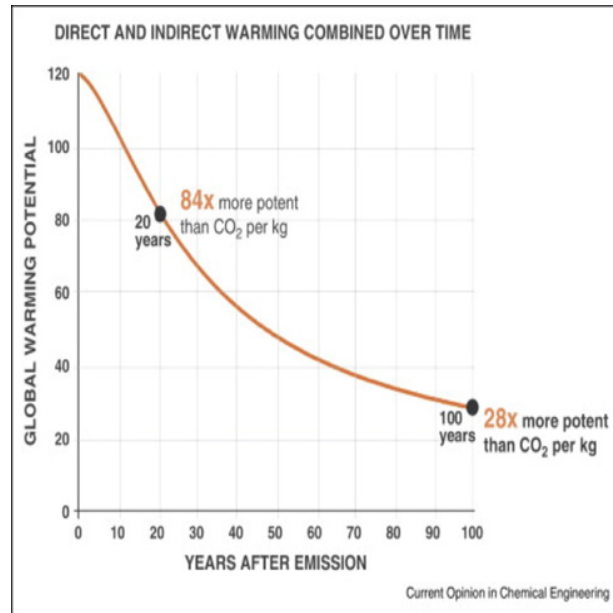
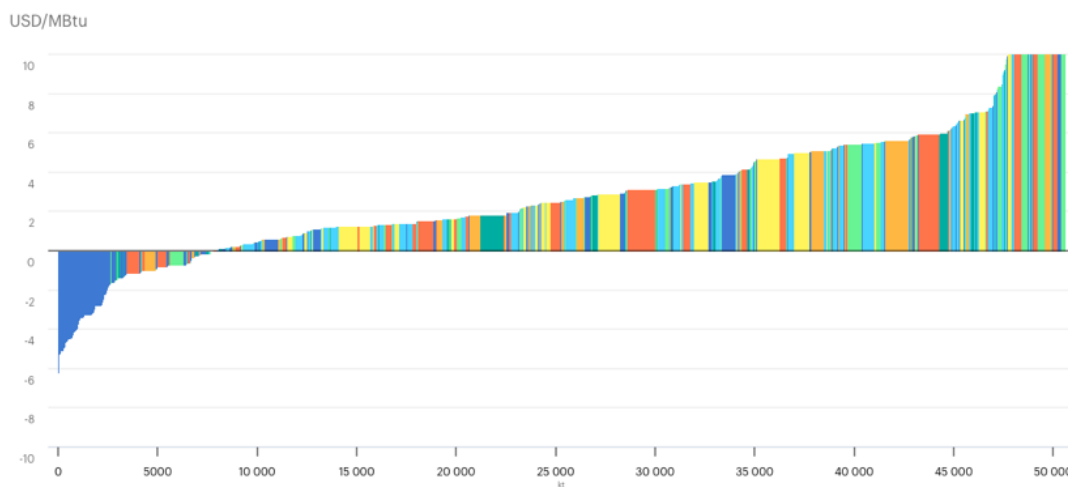


Figure 6: GHG Impact over Time
Image Credit: ResearchGate

Marginal abatement cost curve for oil- and gas-related methane emissions by region, 2020

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● Africa ● Asia Pacific ● Europe ● Latin America ● Middle East ● North America ● Russia & Caspian

Figure 7: Marginal abatement cost curve for oil- and gas-related methane emissions by region, 2020
Image Credit: International Energy Agency

Marginal abatement cost curve for oil- and gas-related methane emissions by region at higher natural gas prices

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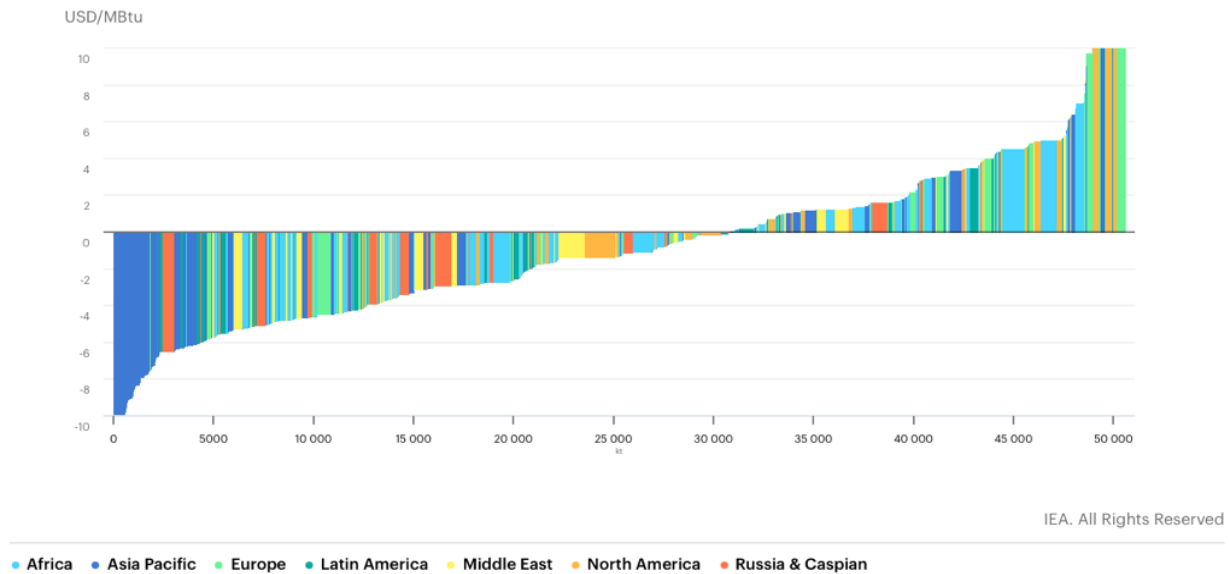


Figure 8: Marginal abatement cost curve for oil- and gas-related methane emissions by region at higher natural gas prices, 2020
Image Credit: International Energy Agency

Methane is the fastest, most cost-effective approach in reducing GHG emissions. The cost of CCS in reducing CO₂ starts at \$50/tonne and can increase to over \$170/tonne. Conversely, methane starts at a negative cost and increases for many technologies to less than \$10/tonne of CO₂ equivalent, unlike CO₂, methane has commercial value; we can sell methane. Methane mitigation cost usually goes down as the gas price goes up.

Natural gas is and will continue to play an important role in the energy system for many years to come. IEA is forecasting that electricity generation from natural gas will increase by over 25% by 2050.

Using methane reforming technology combined with carbon capture, utilization, and storage (CCUS), enables us to generate hydrogen to provide clean transportation fuel at near zero emissions. Work is also in progress for cold conversion of methane to hydrogen at near zero emissions.

Electricity generation with lowest carbon footprints from combustion of natural gas and CCUS, or hydrogen generated from the above technologies are essential for achieving

Electricity generation from selected fuels
(AEO2020 Reference case)
billion kilowatthours

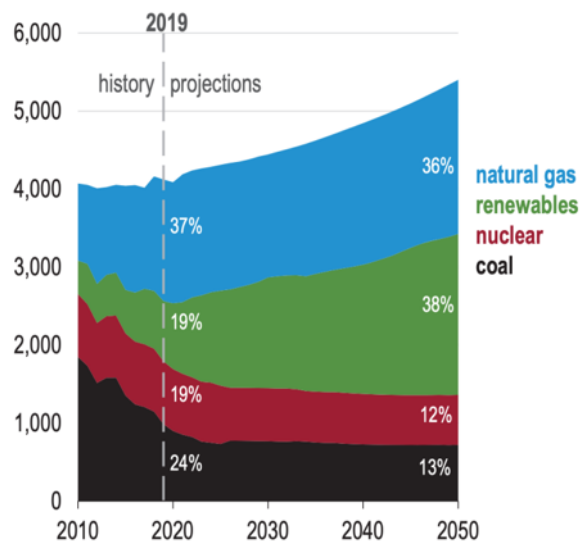


Figure 9: Electricity Generation from Selected Fuels
Image Credit: EIA

net zero by 2050, provided that we significantly reduce methane emissions from production, processing, and transportation of natural gas.

Methane is the key to creating a clean Canadian oil and gas brand. Methane reduction allows more natural gas to be delivered to customers while simultaneously improving our environment. Methane is the catalyst where traditional oil and gas and leading-edge cleantech meet. It has the potential to forever change how we do business by helping small- and medium-sized cleantech companies prosper nationally and internationally. Canada can play a major global leadership role in using methane to generate clean electricity or transportation because we are the global leader in CCUS, hydrogen, and methane detection/ mitigation technologies.

PTAC's Contributions to Methane Emissions Reduction

PTAC's Methane Detection and Mitigation Grand Vision

Through the ingenuity and creativity of Canadian entrepreneurs, Canada holds a leadership role in developing and commercializing methane technologies which can be exported globally. Collaboration between entrepreneurs, technology providers, researchers, producers and government funding organizations is significantly reducing methane emissions – a role model for global collaboration.

Methane Mitigation:

- To increase methane mitigation technology capacity by 45% by 2022 at a cost of less than \$5 per tonne of carbon dioxide equivalent (CO_{2e}). This increased capacity will equip producers to meet the 2025 target.
- Long-term vision is to increase technology capacity by 90% by 2030.

Methane Detection:

- To foster cost-effective accurate technologies that detect methane emissions.

More than a decade ago, PTAC started working on initiatives to reduce methane emissions. The Methane Emission Reduction Network (MERN) was formed to be an innovation network with a vision to connect projects, ideas, people, capital building methane detection, quantification, monitoring and mitigation technologies with the goal to help build enough technology capacity to reduce 45% of 2012 methane emissions at a cost of less than \$5/tonne of CO₂ equivalent by 2022. MERN works in collaboration with Clean Resource Innovation Network (CRIN), and Canadian Emissions Reduction Innovation Network (CERIN). The Network connects PTAC's methane detection and mitigation applied research, technology development, field/lab tests, demonstration, commercialization, and deployment projects.

Applied Research Projects

Our applied research projects have immensely helped oil and gas producers with the needed cost effective and accurate methane detection and mitigation best management practices.

Throughout the past 15 years, PTAC has launched and completed over 450 applied research environmental management projects of which over 40 of the projects were dedicated to detecting methane emissions. Those projects have immensely helped oil and gas producers with the needed cost effective and accurate methane detection and mitigation best management practices. The projects also provided scientific and engineering facts to policy makers and regulatory bodies to develop their smart policies and regulations.

Through PTAC's Alberta Upstream Petroleum Research Fund (AUPRF), several best management practices have been developed to aid in the reduction of fugitive methane emissions from surface vent flow casing, leak detection and repair, mitigating low volume methane emissions, and pneumatic vent gas measurements

Samples of best management practices and applied research projects are shown below:

PTAC Best Management Practices	PTAC Methane Applied Research & Studies
<ul style="list-style-type: none"> • Development of best practices using past AUPRF research projects targeting PTAC focus areas, Plug/annular cement integrity analysis and fault diagnosis of mechanical plugs • Development of a Model to Predict Benzene Emissions from Glycol Dehydrators with Condensation Tanks • Improved Flare Source Parameters for CALPUFF and AERMOD Dispersion Models • Leak Detection and Repair Baseline • Vehicle-based Fugitive Emission Detection and Attribution within Albert Energy Developments • Mitigating Low Volume Methane Emissions • Pneumatic Vent Gas Measurement • Verification of Quantitative Optical Gas Imaging System 	<ul style="list-style-type: none"> • Identification and Evaluation of GHG Reduction & Energy Efficiency Improvement Opportunities at Oil and Gas Facilities • Emissions Reduction opportunities in Dehydration Facilities • Validation of Reduced Spacing from Residences for Enclosed Combustors • Mitigating low volume methane emissions • Field Data Collection Study to Investigate Abnormal Tank Venting • Stationary Engines Air Emissions Research • Petroleum Emissions Management Accelerator (PEMA) – Study of the Potential for Emissions Reductions in Conventional Oil and Gas

<ul style="list-style-type: none"> • Pilot Measurements Study for Quantifying Methane Emissions at Upstream and Midstream Oil and Gas Facilities 	<ul style="list-style-type: none"> • Conceptual Engineering Study of Technologies for Reducing Methane Venting in Cold Heavy Oil Production • Glycol Dehydration Pump Optimization Review • Eco-efficiency Handbook • REMVue Slipstream Industry Impact Assessment
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Fugitive Emissions Management Program Effectiveness Assessment (FEMP EA)

The PTAC Fugitive Emissions Management Program Effectiveness Assessment (FEMP EA) is a world class methane detection, quantification and verification applied research project. FEMP-EA has sought to address the gap in understanding the efficacy of LDAR surveys in addressing methane emissions. This work has created one of the largest and comprehensive data sets of bottom-up methane emissions at oil and gas facilities across Canada and the U.S.

Preliminary analysis is expanding insights on the sources and components most prone to exhibiting high emissions. The study area of 50 x 50 km was chosen based on the density and distribution of facilities in the Red Deer region. Approximately 180 sites were surveyed over 5 different survey campaigns between August 2018 and October 2019 with a focus on fugitive emissions, inventory and venting.

The study was successful in answering a number of important questions including both the incidence and contribution of large leaks (lesser counts of large leaks are more contributory and impactful to emissions), the lasting effects of fixed leaks (prior fallacy that leaks don't stay fixed) and leak success (prior fallacy that leaks only grow). In total, there were 10 conclusions in the study that will potentially frame future methane regulation revisions around testing frequency specifically but also Alt-FEMP's and some standardization potentially of OGI by exclusion only.

The sites were split into four groups – one control group where operators were not made aware of the leaks found by the survey team, and three treatment groups where operators were provided with a list of leaks with the expectation of (voluntary) repair. Part of the reason for not informing operators of leaks in the one identified group was to monitor how leaks manifest over time during subsequent investigations during the study.

The survey team used FLIR GF-320 optical gas imaging (OGI) cameras to detect methane emissions and Providence Photonics' QL-320 tablet for quantification. The study team chose the QL-320 to comprehensively quantify all emissions found at oil and gas sites which would not have been possible with conventional hi-flow sampler measure-

ments. Detailed controlled release calibration of the QL-320 was conducted as part of the Alberta Methane Field Challenge.

PTAC would like to have this data scoured for developing algorithms to obtain patterns that have not become apparent to us. One project could be on simply “cleaning” the data by calibrating the various instruments and eliminating data that is erroneous. A second project would be to determine additional insights from the data. The output from this project would be science-based sampling frequencies and there may be some information on the types/suitability of various sensors. This could lead to developing a predictive methane detection tool and identification of consistently leaking assets for design improvement.



Image Credit: University of Calgary

Alberta Methane Field Challenge (AMFC)

The Alberta Methane Field Challenge (AMFC) phases 1 and 2 were field campaigns conducted in 2019 to assess the performance of new methane leak detection and quantification technologies at producing oil and gas facilities.

Two separate field trials were conducted in 2019, one in June and the other in November. Each of the field trials consisted of approximately two weeks of testing across 50 oil and gas producing sites near Rocky Mountain House, Alberta. The 50 sites were selected by the AMFC’s science team, based on several considerations, including ease of access, site density to minimize travel time between sites, vegetation type, production, and resource characteristics.

The field trials tested five different types of leak detection methods: fixed continuous monitoring systems; handheld devices; truck-mounted sensors; drone-mounted sensors; and aerial systems. During each trial, 2 distinct OGI crews were deployed in step with the other leak detection methods to compare quantification results and limitations in testing time, topography, spatial and temporal characteristics of site emissions, atmospheric conditions and measurement uncertainty. In addition, in the second trial, con-

trolled release testing (CRT) was deployed at one site to provide calibration for QOGI and as a further comparative to other leak detection methods.

Based on the survey results, it is evident QOGI is 82% effective when compared to CRT. In addition, variability in leak detection method quantifications can be isolated to inherent inaccuracies of aggregating equipment level measurements to a site level against those technologies with only site level measurement capabilities (i.e., Aerial). By and large, other than the University of Calgary truck-mounted leak detection method (pictured on page 15), most technologies undershoot QOGI measurements, with overall detection effectiveness between 35% and 94% when excluding outliers.

Overall, 12 technologies were field tested as part of AMFC. The leak detection technologies were chosen through a rigorous application and selection process that took into consideration technological capabilities, prior testing experience, deployment and scalability, and cost. Although the development of new sensors, technologies, and platforms showed faster and more cost-effective methane leak detection than existing approaches in controlled test conditions, there were remaining questions around their field deployment viability. The AMFC program was commissioned to address this critical gap in evaluation of new methane leak detection technologies.

While there has been some existing work on controlled release testing and modeling, the AMFC was the first large-scale field trials of new methane detection technologies.

The AMFC yielded several key insights including:

- Optical gas imaging (QOGI) as a baseline technology is effective in providing comprehensive estimates of aggregate methane emissions at oil and gas facilities. Future studies on the precision of QOGI quantification are recommended.
- Most technologies evaluated in the AMFC are effective at detecting atmospheric methane concentrations and demonstrate wide performance variation across survey speed, localization, and quantification.
- Accurate quantification remains challenging – some technologies can provide good order of magnitude estimates of site-level emissions compared to QOGI.
- In-field controlled releases are effective in assessing the quantification capabilities of new technologies that account for local weather conditions.

This study provided valuable data for operators, regulators, and technology developers to better understand the operational challenges involved in methane emissions detection and quantification using a variety of technologies and platforms.

The Alberta Methane Field Challenge project sought to understand the real-world performance of alternative methane leak detection technologies in comparison to conventional camera-based surveys. The size of the area was 2,500 km², and drones, trucks, and planes were used to detect leaks. The results indicate that using various technologies are effective at detecting emissions at oil and gas sites.



Image Credit: PTAC

Alternative-Fugitive Emissions Management Program (Alt-FEMP) Project

This project focused on Methane emissions detection, attribution, and quantification at upstream oil and gas facilities – a comparison of two truck systems and optical gas imaging. Results indicate strong agreement among the methods for facility-level detections.

Additional Detection Surveys

PTAC is currently applying for additional funding to create a “METEC-type” release site in Alberta. This site will allow for known quantities of methane to be released into the atmosphere. The teams will be able to calibrate against a known release and will need to compensate their measurements through processing to account for wind, humidity, cloud cover, temperature and other meteorological information. The algorithms developed for how methane disperses according to many variables will become the basis for how these teams will calibrate their equipment. This tool will allow for very much improved measurements of methane emissions in Alberta and worldwide.

Cold Heavy Oil Production with Sand (CHOPS)

PTAC has recently launched a program to perform rigorous testing of tank vents and surface casing vent flows from CHOPS wells. This data will be united with flow rates to determine gas/oil ratios (GOR), which is currently the subject of much debate in the research community. There are many variables affecting the measurements including the casing pressure, tubing pressure, reservoir pressure, separator pressure settings, and tank vent pressure. In addition, the temperature of the tubing, separator, tank and the air temperature play a role in these measurements. It is expected that with sufficient data we could develop a predicting tool to estimate methane emissions from tanks.

Methane Mitigation Technology Development, Field Testing, Demonstration, Deployment, and Market Uptake

PTAC's ultimate goal is to launch projects for development, field testing, demonstration, deployment, and market uptake of methane mitigation technologies to meet our short- and long-term goals of building 45% and 90% by 2022, and 2030 respectively.

Methane Detection Technologies Developed through PTAC

- mAIRsure
- LDAR SIMS
- Intelligent Methane Measurement, Monitoring and Mitigation system (IM3S)
- Distributed Energy Efficiency Project Platform (DEEPP) – DEEPP,
- Methane Abatement Platform Phase 1 - Engagement Plan (2017)

Methane Detection Technologies Deployed/Demonstrated through PTAC

- SeekOps, (Drone)
- Heath Consultants Inc. (Drone)
- Aerometrix (Drone)
- Altus Technologies (Truck)
- Heath Consultants Inc. (Truck)
- University of Calgary (Truck)
- Bridger Photonics (Aerial)
- Sander Geophysics Ltd. (Aerial)
- FLIR (Handheld)
- Tecvalco (Handheld)
- Luxmux (Ground-based)
- NitroTech (Controlled release)

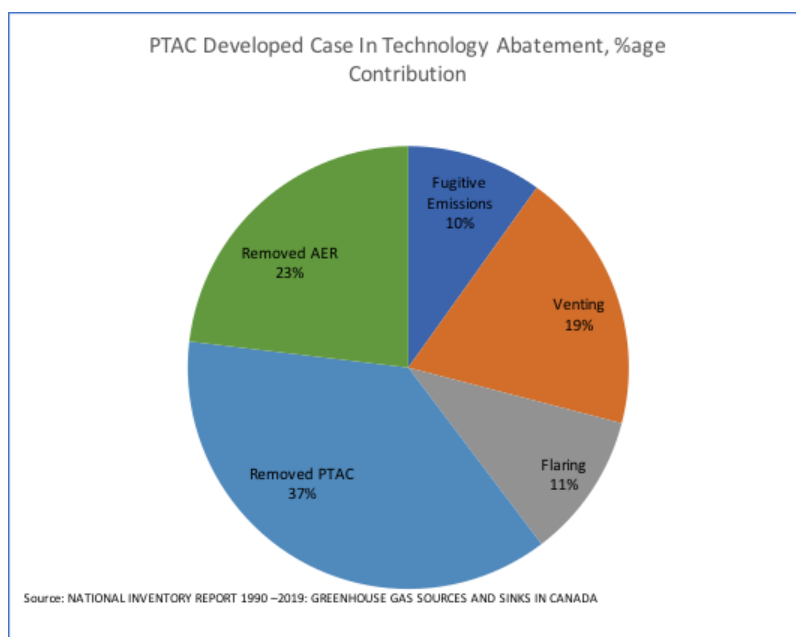


Figure 10: PTAC Developed Technology, Percentage of Abatement
Image Credit: PTAC

PTAC Collective Technology Capacity Developed Through Technology Development

Over the past 15 years, PTAC through the NRC/IRAP program, funds from Alberta Innovates, NRCan, Emission Reduction Alberta have secured funds to help SME developed their technologies. **The Methane Mitigation Technologies Developed through PTAC collectively have capacity to reduce oil and gas sector's methane emissions by 37%:**

- LCO Chemical Pump
- LCO Instrument Air
- PureJet Combustor
- Electric Dump Valve Actuator (EDVA)
- Calscan Electric Wellsite
- Trido Chemical Pump
- Multilateral Junction by ModernWellbore
- 2 technologies through CanERIC

More information on each technology is provided in **Appendix A**.

PTAC Collective Technology Capacity Developed Through Field Tests

PTAC's Field testing SME's technologies have addressed the SME's biggest challenge, known as the valley of death. An example of the technologies commercialized through the PTAC consortia is the REMVue technology (pictured), which captures methane and other light hydrocarbons to utilize as fuel for operations. This technology is currently reducing GHG emissions equal to taking 175,000 cars off the road annually while reducing industry cost by \$20 million



Image Credit: PTAC

per year. Even with this impressive performance, the uptake of this technology is low. The technology provider has declared that so far 7 million of Cumulative CO₂e has been reduced through this technology.

Consortium of Methane Detection, and Mitigation Test Facilities (CanERIC)

In 2017, we decided it was time to take a more systematic approach to addressing the valley of death challenge so, a consortium of field-testing facilities was formed, which is known as the Canadian Emissions Reduction Innovation Consortium, or CanERIC.

In essence, we created an impressive network of testing facilities, located from the East coast to the West coast. By securing funds from Alberta Innovates and Natural Resources Canada.

Locations of Field Facilities, Labs & Organizations



Figure 11: Locations of Field Facilities, Labs & Organizations

Image Credit: PTAC

This consortium consists of 14 producers, and 16 universities & research centres in Canada and the United States who have dedicated their field and lab facilities, worth over a billion dollars, to CanERIC. PTAC, with industry support, has been able to help SMEs field test their technologies at no cost to them. So far, three technologies have been lab tested, nine technologies have been developed and/or field tested, and six technologies are undergoing various tests.



Figure 12: CanERIC Producer Members

Image Credit: PTAC



Figure 13: CanERIC Research Institution/Academia Members

Image Credit: PTAC

The majority of the field-tested technologies are through consortia; however, the CanERIC facilities are currently field-testing the majority of technologies. **The Methane Mitigation Technologies Field Tested through PTAC collectively have the capacity to reduce oil and gas sector's methane emissions by 48%:**

- 8 technologies through CanERIC
- LCO Chemical Pump
- LCO Instrument Air
- PureJet Combustor
- Electric Dump Valve Actuator (EDVA)
- Calscan Electric Wellsite
- Trido Chemical Pump
- Trido Instrument Air
- Zero Emissions Wellsite – Demonstration of New Technology by Trido Industries for Eliminating Emissions at Remote Well Sites
- Blue Source low bleed chemical pump
- REMVue SlipStream
- Analysis and Report of SlipStream® GTS-DeHy Auxiliary
- Burner System in Glycol Dehydration Units (2016)
- Gas Pro Vapour Recovery Unit Evaluation Study (2016-2017)
- Heavy Oil Emissions EcoEII

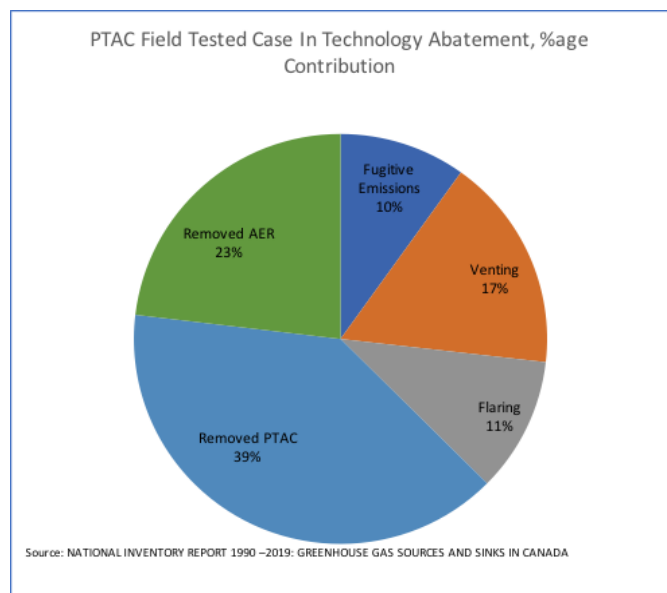


Figure 14: PTAC Field-Tested Technology, Percentage of Abatement
Image Credit: PTAC

More information on each technology is provided in **Appendix A**.

PTAC Collective Technology Capacity Developed Through Field Demonstration

These consortia aim to increase the investment in massive deployment of such tech-

nologies by producers, hence increasing market uptake. These consortia have resulted in installing 101 pieces of equipment, including 10 site electrifications, 37 pump optimizations, 26 smart pumps, 14 STD Electrics, 12 Instrument Air Compressors, one facility of the future, and one compressor engine. These technologies collectively are reducing ~90,000 tonnes of methane emissions.

It has been estimated that the upside potential in mass deployment of the identified technologies is at least 5,000 site electrifications, 5,000 pump optimizations, and 5,000 instrument air compressors, 10,000 smart chemical pumps, 10,000 STD Electric chemical pumps, and 500 compressor engines installed in oil and gas facilities in Canada.

Using this estimate, the collective technology capacity of the above methane mitigation technologies developed, field tested, and demonstrated, yield outcomes aligned with previous approaches in impact assessments.

Project Lead	Project	# of Sites/Units	Total Annual Mitigated CO ₂ e/project (tCO ₂ e)	Total GHG Reductions (tonne CO ₂)	Forecast Number of Installations
CalScan	Zero Emission Linear Electric Actuators (level & Process Control)	10	1216.00	18,240	5000
Cenovus	Facility of the Future including: electric instruments & pumps, instrument air, and remote on-site power generation.	1	865.80	8,658	
Ember	Engine Modernization - Waukesha Series 5	1	2080.00	20,800	500
Spartan	Reduction of Vented Methane Emissions Through The Crossfire Instrument Air Compressor	12	635.00	5,080	5000
Spartan LCO	LCO Crossfire Chemical Injection Pump	26	2738.60	21,909	10000
BlueSource	Retrofitting Gas-Driven Pneumatic Pumps To Reduce Methane Emissions is Feasible, Cost-Effective and Results in Material GHG Reductions	37	674.00	6,740	5000
NAL	Grid Powered Site Conversions	14	817.00	8,170	10000
		101	9,026	89,597	

Figure 15: Methane Consortia Program Project Suite (2020/2021)

Image Credit: PTAC

The Methane Mitigation Technologies/Projects Deployed/Demonstrated through PTAC have the collective capacity to reduce oil and gas sector's methane emissions by 39%:

- LCO Chemical Pump
- LCO Instrument Air
- Trido Chemical Pump
- Trido Instrument Air

- AirTeck Systems
- Ironline Compression
- Texsteam Chemical Pump
- MCI Chemical Pumps
- Sirius Chemical Pump
- Eagle Power Supply
- Clear Rush Combustor
- The REMVue® AFR and Slip-Stream® Technology – By Spartan Controls
- The LP Vapour Combustor – By Black Gold Rush Industries Ltd
- Zero Emissions Wellsite by Cenovus
- Zero Emissions Wellsite – BP Canada Validation of Sun Pumper versus Tex Steam Units
- Field Evaluation of the REMVue Low Horsepower (LHP) Technology

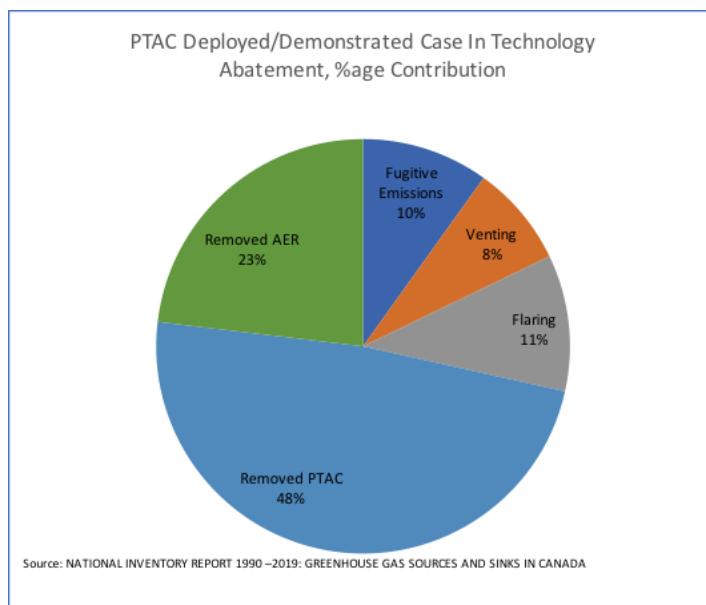


Figure 16: PTAC Deployed/ Demonstrated Technology, Percentage of Abatement
Image Credit: PTAC

More information on each technology is provided in **Appendix A**.

Facing SMEs' Market Up-take Challenge

Even if a technology is field tested and proven to be cost-effective and reduce methane emissions, the SMEs still face the challenge of increasing the market uptake of that technology.

To attempt to mitigate this challenge, PTAC launched two consortia that pay up to 75% of the cost of equipment and installation of cost-effective methane mitigation technologies, encouraging Canadian producers to get a first-hand experience with the new technologies. These consortia aim to increase the investment in massive deployment of such technologies by producer, hence increasing market uptake.

Canadian Capabilities in Methane Emissions Reduction

To further increase the market uptake of SME's technologies we also created the [Canadian Capabilities in Methane Emissions Reduction Guide and Directory](#) listing over 59 Canadian cleantech companies looking to bring their methane technologies to international markets. PTAC's product-market-fit assessments help cleantech SMEs prosper. Last year alone PTAC completed 55 assessments with the financial help from NRCan/IRAP and launched 20 consortia to help SMEs achieve economic prosperity.

Products	Description
Combustion	99.9% efficient at converting methane
Compress Methane	Compress methane back into sales
Instrument Air	Compress air to deliver power to pneumatics
Chemical Pumps	Electrically powered pumps
Electric Devices	Replace pneumatically operated devices
Electricity Generation	Create electricity by burning methane
Cement Alternatives	Products to replace cement in wells

Services	Description
Detection, Measurement, Quantification, Monitoring	Supply services to detect and monitor emissions
Research	Research labs to validate equipment for service
Reporting	Generating reports for companies and government
Management	Overall management from measurement and reporting, to strategic methods of optimizing money spent on this challenge
New Technology/Redesign	Typically engineering companies who evaluate the existing processes and redesign the systems to reduce emissions

In the coming year, PTAC will launch several new initiatives to expand our international activities. This will include a strategic program to increase international sales of Canada's cleantech products and technologies. In closing, reducing methane emissions requires global collaboration. It is through this collaboration that PTAC has achieved so much.

Appendix A - Technology Descriptions

AirTek Systems – www.airteksystems.com/aurora-2-2

AirTek provides instrument air solutions to the industry including conversion from instrument pneumatic gas assist to instrument air assist solutions to eliminate site methane venting. Their design purports “the world’s only DC powered rotary screw instrument air system”. Instrument air is becoming more prevalent in the industry and competes well with site electrification projects on abatement cost and long-term viability.

Analysis and Report of SlipStream® GTS-DeHy Auxiliary Burner System in Glycol Dehydration Units (2016)

The SlipStream® GTS-DeHy system is a proprietary technology owned by Spartan Controls. It collects the still column vented gasses on glycol dehydrators and uses it for fuel. The system utilizes a main burner and an auxiliary burner mounted in the main burner exhaust stack. The main burner is supplemented using primary fuel gas when the still column vent gas is unavailable. Two field trials were undertaken to demonstrate the operation of the system. The system has proven that it is a reliable technology that can be used by Operators to virtually eliminate the BTEX vented emissions from Glycol dehydrators. The SlipStream® GTS-DeHy technology is expected to provide a cost effective, reliable solution for BTEX emission elimination from glycol dehydrators.

Blue Source low bleed chemical pump (MCP)

This project was to identify potential methane emission reductions evident through optimization of stroke length and plunger size in Texstream 5100 Series chemical pump configurations. Specifically, field candidates with 3/8” plunger size configurations optimized to 1/2” at full stroke length (1”) were identified to calculate potential emission reductions at constant injection rates and pressures. This type of project is very simple and if widely adopted, could have material benefit to the industry.

Calscan Bear Solar Electric Control System

The Bear Solar Electric Control System for well head separators is a low power electric control system that replaces the pneumatic controls operating off fuel gas. Removing the need for fuel gas solves many of the problems the industry has on separators such as: Low Pressure Gas; Wet Gas; H₂S in Fuel Gas; Using Propane for Fuel Gas; and Reducing Greenhouse Gases.

Clear Rush Enclosed Vapour Combustor

Clear Rush Co (CRC) products include its patented enclosed vapour combustors designed for low pressure, low volume vent gas from sources such as casing gas, storage tanks, and pneumatic instruments. It designs and manufactures industry leading ACL burner management systems as well as provides waste gas to power technology. The Clear Rush enclosed vapour combustors are designed to be the safest combustors on the market. CRC has been the pioneer in enclosed vapour combustor technology and

works with producers and regulators to ensure that the units can be safely operated within reduced spacing scenarios.

Eagle Power Supply – www.eagle-pc.com

Eagle provides instrument air solutions to the industry including conversion from instrument pneumatic gas assist to instrument air assist solutions to eliminate site methane venting. Eagle carries a variety of air compressor and air dryer designs. Instrument air is becoming more prevalent in the industry and competes well with site electrification projects on abatement cost and long-term viability.

Field Evaluation of the REMVue Low Horsepower (LHP) Technology

The expected Canadian regulations for NOx and CO emissions from existing, non-emergency natural gas engines > 100 to 200 kW will require the application of control technology to most existing engines. The recently developed REMVue® LHP (low horsepower) technology provides a way to meet these regulatory limits for turbocharged engines in the 100 to 600 kW range by means of lean combustion. The report, commissioned by the PTAC and carried out by REM Technology Inc. (RTI), contains the findings from the application of the REMVue® LHP technology to 3 different engine models in the 100 to 600 kW size range that are in regular field service. The project duration was 24 months.

Gas Pro Vapour Recovery Unit Evaluation Study (2016-2017)

See PTAC website: <https://www.ptac.org/wp-content/uploads/2017/07/GasPro-Final-Report-Rev-1-July-2017.compressed-1.pdf>

Heavy Oil Emissions EcoEII

See link to the public report on the NRCAN website: <https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/current-investments/emissions-reductions-and-energy-efficiency-crude-bitumen-and-heavy-oil/19371>

LCO Chemical Injection Pump

The LCO Technologies CROSSFIRE Solar-powered Chemical Injection Pump is an ultra-low power device that is designed to reduce chemical costs, maintenance costs and methane emissions. It is a durable, energy-efficient solution like no other that can run for weeks – not days – even in areas with limited sunlight. It can be configured with one to four fluid ends, allowing you to replace up to four pneumatic pumps with one unit.

LCO Instrument Air Compressor

The LCO Technologies CROSSFIRE Instrument Air Compressor is an ultra-low power device that produces over 1100 Standard Cubic Feet per Day of clean, dry compressed air at 35 PSI using solar power, or over 900 Standard Cubic Feet per Day at 50 PSI. It can allow users to maintain their existing standard pneumatic instrumentation in areas where the goal or requirement is to achieve zero venting.

Linear Motion Technologies (LMT) Electric Dump Valve Actuator (EDVA)

Linear Motion Technologies (LMT) Electric Dump Valve Actuator (EDVA) will both re-

place a large percentage of pneumatic devices currently in use and provide a more efficient and affordable alternative for new installations. Replacing pneumatic actuators with EDVAs completely eliminates all associated methane emissions. Furthermore, the EDVA requires fewer and far simpler parts than competitive devices, resulting in a more reliable technology that is cheaper and easier to install and maintain.

The LP Vapour Combustor – By Black Gold Rush Industries Ltd

The BGR Cube is a highly versatile, low cost vapour combustor designed to destruct volatile organic compounds (VOCs) and BTEXs produced from casing gas, pneumatic devices, or storage tanks. The BGR Cube eliminates the need to install expensive vapour recovery units (VRU) or uneconomical incinerators that provides an economical alternative to venting or flaring. The high efficiency burner provides low pressure continuous burning capabilities, high combustion efficiency, low emissions, zero odours, no visible flame, and increased flame stability with excellent turndown ratios for low pressure applications.

MCI Chemical Injection Pumps

MCI Chemical injection pumps, 12V DC and 24V DC, are high-efficiency electric pumps that totally eliminate methane emissions. The minimum power drawn by these electric pumps make them ideal for alternative energy powered applications. MCI's products work to contain any chemical leaking associated with conventional chemical injection pump V-packing, found in many chemical injection pumps, by internally porting and redirecting the leaking chemical back to the suction side of the pump. By using MCI pumps, operating costs are reduced and drive gas stays in the line for future processing and sales. Maintenance over the life of the plunger seals is reduced to zero. Penalties associated with methane gas emissions are eliminated.

Modernize of Waukesha Engines

Ember Resources worked with Ironline Compression to modernize a Waukesha Engine. This consisted of an upgrade/conversion of a Waukesha 7042GL (Series 2) to the latest technology available from the Original Equipment Manufacturer (OEM), the Waukesha Series 5. The Waukesha Series 5 consists of redesigned engine components, control systems, and catalyst technology designed to achieve substantial GHG reductions. The application of this technology reduces the carbon footprint, increase reliability, and lowers operating and maintenance costs by increasing the maintenance interval and the equipment life cycle.

Multilateral Junction by Modern Wellbore

Modern has developed a downhole multilateral junction for shale oil & gas producers that enables multiple lateral wells to be drilled and accessed from a single well pad -reducing drilling and associated cost and emissions. The core technology simplifies installation, provides flexible well access, and enables operation in high-pressure fracturing environments.

PureJet Combustor

The PureJet is a family of incinerators that apply patented aerospace technologies to efficient waste gas destruction. A major component of the operation of PureJet is its patented intake system. Providing sufficient air to facilitate the combustion of a large amount of waste gas is a complex engineering challenge. PureJet's unique design allows it to achieve high capacities and turn down ratio. PureJet is designed to integrate into existing facilities for ease of deployment and ability to tie into existing infrastructure. Further research is being done to integrate PureJet with waste-heat-to-power and water recovery technologies. PureJet is a quick and cost-effective solution to emissions compliance.

The REMVue® AFR and SlipStream® Technology – By Spartan Controls

The REMVue® AFR is an advanced air-fuel ratio control system for performing a rich-to-lean conversion, as well as engine control and optimization. The system can be configured as an effective stand-alone control system, or can be integrated to work in conjunction with other hardware/software systems like the SlipStream® vent capture to make the most effective impact.

SlipStream® is a proprietary, patented technology that utilizes vented hydrocarbons that would otherwise be lost to the atmosphere, as a supplementary fuel source for natural gas engines. SlipStream® technology monitors and controls the addition of these vented hydrocarbons to ensure safe and reliable engine operation.

Sirius Chemical Injection Pump

Sirius Instrumentation & Controls is breaking down barriers to make solar-powered chemical injection pumps practical and economical, paving the way to help the oil and gas industry reduce its environmental footprint. Sirius solar pumps can replace up to 15 pneumatic pumps on a site with one Sirius solar pump set up. Through significant chemical and manpower savings, Sirius has turned solar pumps into both a profitable and environmental solution. The savings are much larger through optimized production and reduced well workover costs. Cost abatement is well under \$4/tCO₂e and the pumps are eligible for carbon credits.

Texsteam Chemical Pump

Texsteam chemical pumps and knock-offs (ie. Bruin, CVS) are the workhorse pneumatic-driven chemical pump in the Canadian oil and gas industry accounting for an estimated +65% of all pneumatic-driven pumps operating today (one operator statistic). The Series 5100 and 5000 designs are used in a variety of field applications with the Series 5100 pump being the more prevalent of the two. Predominant chemical pumped is methanol.

TRIDO Chemical Injection Pump

TRIDO's Solar Powered Chemical Injection Pumps leverage field-proven actuator technology to deliver chemical year-round with precision and reliability while eliminating venting.

TRIDO Instrument Air Compressor

The TRIDO Solar Powered Instrument Air Compressor is a realistic solution for creating an emissions free well site. This simple design combines cutting-edge motor technology with the TRIDO VFD Controller.

Zero Emissions Wellsite by Cenovus (MCP)

This novel project sought to simultaneously trial three variations of a zero-emission arrangement on a 3-well pad using various vendor combinations of instruments & pumps, instrument air, and remote on-site power generation. The goal of the project is to eliminate vented methane emissions from natural gas-driven pneumatic equipment on standard well site separator packages in advance of new regulation requiring greenfield sites to be zero emitting.

Appendix B - Acknowledgements

PTAC would like to extend a special thanks to Mr. Brian Spiegelmann for providing assessment on PTAC's technology capacity, and Ms. Lauren Arthur for graphs, pictures and editing.

PTAC would also like to thank its staff: Mr. Allan Fogwill, Mr. Larry Fredrick, Ms. Lorie Mayes, Ms. Marie-Lianne Willams, and Ms. Tannis Such for their tireless work, commitment and energy

In addition, PTAC would like to extend big thank to the following organizations, and individuals for providing funds, their time and support - PTAC could not have done accomplished this without you.

Air Research Planning Committee (ARPC)

ARPC supports industry's desire for shared research development to develop credible and relevant information to address knowledge gaps in the understanding and management of high priority environmental and social matters. Our goal is to initiate credible research projects, both fundamental and applied, on existing and emerging environmental issues to support both development of new regulatory requirements and industry best practices.

Committee Members:

- Brian Spiegelmann, PTAC
- Bruce Fraser, Environment and Climate Change Canada
- Cassandra Schostek, Alberta Energy Regulator
- Colin Hennel, Bonavista Energy
- Don D'Souza, BC Oil and Gas Commission
- Don McCrimmon, Canadian Association of Petroleum Producers (CAPP)
- Filiz Onder, Encana
- Gerald Palanca, Alberta Energy Regulator
- Greg Unrau, Repsol
- Jacob Bayda, Saskatchewan Ministry of Energy and Resources
- James Beck, Suncor Energy
- Johnny Matta, Environment and Climate Change Canada
- Koray Onder, TC Energy
- Marie Johnson, BC Oil and Gas Commission

- Mark Anderson, Husky Energy
- Moruf Aminu, Encana
- Neuczki Mathurin, TC Energy
- Paolo Bomben, Alberta Innovates
- Randy Dobko, Alberta Environment and Parks
- Rekha Nambiar, Suncor Energy
- Richelle Foster, Canadian Natural Resources
- Roopa Ganapathy, Environment and Climate Change Canada
- Sean Hiebert, Cenovus
- Sean Mercer, Imperial

Canadian Emissions Reduction Innovation Consortium (CanERIC)

The Canadian Emissions Reduction Innovation Consortium is a network of emissions reduction test facilities with a vision to encourage national integration and collaboration, avoid duplication, host open information sharing and maintain Canadian global innovation leadership. CanERIC will be anchored by its founding members but will accept new members to provide facilities responding to innovation needs of TRL 5-9 technologies.

Infrastructure Steering Committee Members:

- Aravinder Kumar, Harrisburg University
- Bob Davies, Southern Alberta Institute of Technology
- Chris Hugenholtz, University of Calgary
- Clay Bell, Colorado State University
- Dave Risk, St. Francis Xavier
- Erica Emery, Saskatchewan Research Council
- Erin Powell, Saskatchewan Research Council
- Fred Wassmuth, Innotech Alberta
- James Brydie, CanmetENERGY
- Jason Olfert, University of Alberta
- Ken Omotani, Southern Alberta Institute of Technology
- Kirk Osadetz, CMC Research Institutes
- Kyle Daun, University of Waterloo
- Larry Kostiuk, University of Alberta
- Lesley McGilp, Saskatchewan Research Council
- Matt Johnson, Carleton University
- Mohammad Latifi, Polytechnique Montreal
- Nader Mahinpe, University of Calgary
- Neil Yaremchuk, Innotech Alberta
- Scott Mundle, University of Windsor
- Vita Martez, Southern Alberta Institute of Technology

Industry Solutions Steering Committee Members:

- Abbas Ali Beg, ATCO
- Dan Morrison, InterPipeline
- Gary Shum, Ovintiv
- Jason Brannick, Canadian Natural Resources Ltd.
- Kendell Esau, Bonavista
- Lisa Song, Chevron
- Mark Bohm, Suncor
- Morgan Wrishko, Cenovus Energy
- Neuczki Mathurin, TC Energy
- Patrick Kitchin, Whitecap
- Richelle Foster, CNRL
- Scott James, Velvet Energy
- Sean Mercer, Imperial
- Stephanie Neilson, ARC Resources
- Vincent Saubestre, Total E&P Canada Ltd.
- Yori Jamin, PETRONAS

IM3S Steering Committee

This collaborative steering committee oversees the development of numerical modelling to inform the design of alternative fugitive emissions management programs.

Committee Members:

- Richelle Foster, Canadian Natural
- Chris Hugenholtz, University of Calgary
- Thomas Fox, Highwood Environmental Management

- Jessica Shumlich, Highwood Environmental Management
- Kris Stephansson, Alberta Innovates

Methane Consortia Program (MCP) Steering Committee

In our constant endeavor to lower methane emissions through innovation, PTAC – along with Alberta Environment and Parks– formed the Methane Consortia Program. This collaborative committee promotes the deployment of innovation within the Alberta oil and gas sector.

Committee Members:

- Heather Carmichael, Alberta Environment and Parks
- Monica Micak, Alberta Environment and Parks
- Chris Hugenholtz, University of Calgary
- Gerald Palanca, Alberta Energy Regulator

PureJet Steering Committee

When flaring is unviable or uneconomic, venting may occur. Targeted at eliminating this risk, PTAC is facilitating the PureJet project with collaborators Cenovus Energy, Husky Energy, and Alberta-based Atlantis Research Labs to develop the PureJet Incinerator. This device, coupled with its ability to handle a wide range of pressures and flow rates, enables methane to be destroyed at sites.

Committee Members:

- Aaron Baugh, Emissions Reduction Alberta
- Owen Henshaw, Cenovus Energy
- Vladimir Mravcak, Atlantis Research Labs
- Janelle Mravcak, Atlantis Research Labs

STV Steering Committee

There is a major gap that hampers the validation, adoption, and deployment of innovative emissions reduction technologies in Alberta's oil and gas sector. The STV steering committee works to remove a critical barrier to the widespread deployment for a cohort of technologies, allowing them to cross over the chasm that separates them from full commercialization.

Committee Members:

- Richelle Foster, Canadian Natural
- Patrick Kitchin, Whitecap Resources
- Morgan Wrishko, Cenovus Energy
- Kris Stephansson, Alberta Innovates

Technology for Emissions Reduction and Eco-Efficiency (TEREE) Program

TEREE is a network of industry, services, products technology providers, and provincial and federal government representatives convened to oversee finding and implement-

ing new technologies and methods required to achieve air emissions reductions in the Oil and Gas industry. TERE projects have made a significant contribution to industry through the transfer of technologies used globally in the sector.

Committee Members:

- Adele Zenide, Canadian Natural
- Andrew McClausland, Radicle
- Arvinder Kainth, NRC – IRAP
- Brenna Barlow, Radicle
- Patrick Kitchin, Whitecap Resources
- Bruce Duong, Alberta Innovates
- Catherine Thistlethwaite, Alberta Energy Regulator
- Charles Ward, Alberta Department of Energy
- Chelsea O'Connor, SFC Energy Canada
- Cooper Robinson, Radicle
- Dean Anderson, Baseline Regulatory Compliance Services
- Derek Kelly, Natural Resources Canada
- Derek L'Hirondelle, SFC Energy Canada
- Don McCrimmon, CAPP
- Don D'Souza, Government of British Columbia
- Cam Dowler, Spartan Controls
- Gerald Palanca, Alberta Energy Regulator
- Greg Unrau, Repsol
- James Holoboff, Process Ecology
- Joshua Anhalt, GreenPath Energy
- James Beck, Suncor
- Jamie Callendar, Callendar Energy Services
- Jessica Schumlich, Highwood Environmental Management
- Thomas Fox, Highwood Environmental Management
- Jonathan Smith, Blue Source Canada
- Kelly Newnham, Advisian
- Kelly Parker, COSIA
- Kelsey Locke, Blue Source Canada
- Kirk Osadetz, CMC Research Institutes
- Kevin Heal, Radicle
- Kourosh Zanganeh, Natural Resources Canada
- Lisa Studzinski, Enerplus
- Logan Leduc, Environment Canada
- Mark Jamieson, Alberta Energy
- Mark Summers, Emissions Reduction Alberta
- Mike D'Antoni, GreenPath Energy
- Michael Lawson, Alberta Energy Regulator
- Milos Krnjaja, Alberta Energy Regulator
- Paul Jiapizian, Environment Canada
- Rao Ravi, Spartan Controls
- Ray Lambert, Cenovus Energy
- Rick Phaneuf, Alberta Environment and Parks
- Richelle Foster, Canadian Natural
- Rekha Nambiar, Suncor
- Ron Quick, NRC – IRAP
- Roy Hunt, Advisian
- Ryan Streams, Kairos Aerospace
- Scott Smith, Cenovus Energy
- Sean Hiebert, Cenovus Energy
- Tyler Tarnoczi, Cenovus Energy
- Brian Van Vliet, Spartan Controls
- Wes Funk, DXD Consulting
- Yonathan Dattner, Luxmux Corporation
- Cassandra Schostek, Alberta Energy Regulator
- Owen Henshaw, Cenovus Energy
- Moruf Aminu, Ovintiv
- Sean Mercer, Imperial
- Monica Sippola, Kuva systems
- Neuczki Mathurin, TC Energy
- Koray Onder, TC Energy
- Morgan Wrishko, Cenovus Energy
- Connor O'Shea, Westgen Technologies
- Kevin Schatz, Birchill

CanERIC Producers

- ARC Resources
- ATCO
- Bonavista Energy
- Canadian Natural Resources
- Cenovus Energy
- Chevron
- Inter Pipeline
- NuVista Energy
- Ovintiv
- Petronas
- Suncor
- TC Energy
- Total
- Velvet Energy
- Whitecap Resources

CanERIC Research Institutes/Academia

- CanmetENERGY
- Carleton University
- CMC Research Institutes
- Colorado State University
- Harrisburg University
- InnoTech Alberta
- Polytechnique Montreal
- Saskatchewan Research Council
- Southern Alberta Institute of Technology (SAIT)
- St. Francis Xavier University
- University of Alberta
- University of Calgary
- University of Waterloo
- University of Windsor

Funding Organizations

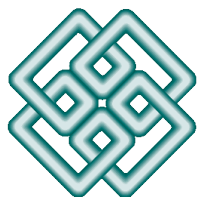
- Alberta Innovates
- Emissions Reduction Canada
- Global Affairs Canada Trade Commissioner Service
- National Research Council of Canada's Industrial Research Assistance Program (NRC/IRAP)
- Natural Resources Canada
- Prairies Economic Development

Technology Providers

- Airdar
- Alberta Welltest Incinerators
- Arolytics Inc.
- Blair Air Systems
- Bruin Instruments Corp.
- Calscan Solutions
- Canadian UAVs
- Carbon Connect International
- Caron Measurement & Controls Ltd.
- Clarifi Inc.
- Clear Rush Co.
- Clearstone Engineering Ltd.
- CMC Research Institutes Inc.
- CNTRAL Inc.
- Compact Compression
- Current Surveillance Inc.
- Durlon Sealing Solutions
- Emissions Rx Ltd.
- Energy & Emissions Research Lab
- enSift Corp.
- Envirosoft Corporation
- EnviroTrace Ltd.
- Envision Manufacturing & Supply Ltd.
- Eosense
- Gas Recon Inc.
- Gaspro Compression
- General Magnetic Canada Inc.
- GHGSat
- Global Power Technologies Inc.
- GreenPath Energy Ltd.
- Highwood Emissions Management
- IJACK Technologies Inc.
- IntelliView Technologies Inc.
- Intricate Group Inc.
- Kathairos Solutions Inc.
- LCO Technologies
- MCI Solar Mfg Ltd.
- Modern West Advisory, Inc.
- Montrose Environmental Group Ltd.
- NexSource Power Inc.
- NEXT Compressions Corporation
- OilPro Oilfield Production Equipment Ltd.
- Pluto Ground Technologies
- Process Ecology
- PureJet Inc.
- Questor Technology Inc.
- Radicle
- SensorUp
- SFC Energy Ltd.
- Sirius Instrumentation and Controls
- Solution Corp Inc.
- Spartan Controls
- Telops
- Total Combustion Inc.
- Valence Natural Gas Solutions
- Vapure Engineering Ltd.
- Ventbuster Instruments Inc.
- Westgen Technologies

Appendix C - Glossary

- **AI** – Alberta Innovates
- **Alt FEMP** – Alternative Fugitive Emissions Management Program
- **AMFC** – Alberta Methane Field Challenge
- **AUPRF** – Alberta Upstream Petroleum Research Fund
- **CanERIC** – Canadian Emissions Reduction Innovation Consortium
- **CCS** – Carbon Capture & Sequestration
- **CCUS** – Carbon Capture, Utilization & Storage
- **CERIN** – Canadian Emissions Reduction Innovation Network
- **CHOPS** – Cold Heavy Oil Production with Sand
- **CO₂e** – Carbon Dioxide Equivalent
- **CRIN** – Clean Resource Innovation Network
- **ERA** – Emissions Reduction Alberta
- **FEMP EA** – Fugitive Emissions Management Program Effectiveness Assessment
- **GHG** – Greenhouse Gas
- **GOR** – Gas/Oil Ratio
- **GWP** – Global Warming Potential
- **IEA** – International Energy Agency
- **LDAR** – Leak Detection and Repair
- **NRCan** – National Resources Canada
- **NRC/IRAP** - National Research Council of Canada's Industrial Research Assistance Program
- **MERN** – Methane Emissions Reduction Network
- **SME** – Small- to Medium-Sized Enterprise
- **VOC** – Volatile Organic Compound



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