Advancing To Net-Zero: Development, Field Testing, and Deployment of Methane Detection and Mitigation Technologies

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Table of Contents

EXECUTIVE SUMMARY

Methane emissions reduction is the fastest, most cost-effective approach in reducing global GHG emissions. Without reducing methane emissions, the oil and gas sector cannot achieve net-zero. Reducing methane emissions has the potential to forever change how we do business by helping Canadian small and medium-sized cleantech companies prosper nationally and internationally. The reduction of methane emissions from oil and gas activities improves not only the environment, but the health of all living beings.

This report outlines the 89-methane detection and mitigation technologies which have been developed, field-tested, demonstrated, commercialized, and deployed through various consortia. These initiatives have played a pivotal role in reducing methane emissions from the oil and gas operations by over 45% in Canada.

Nearly two decades ago, we started working on initiatives to reduce methane emissions. We created the Methane Emission Reduction Network (MERN) to connect people, projects, ideas, and capital, with a short-term goal to build a methane mitigation capacity by 2022 to help the oil and gas industry reduce its emissions by 45% of the 2012 level by 2025. We met and exceeded this target a year earlier, in 2021, through the execution of over 40 technologies developed, field-tested, and demonstrated through various consortia. As of 2023, the number of technology projects launched through PTAC that are dedicated to methane detection and mitigation has more than doubled, with 89 projects launched, 29 of which saw technologies developed, 85 field tested, and 51 deployed (refer to Appendix B).

Overall, our grand vision is to build enough technology capacity by 2030, capable of reducing methane emissions by 90% from the 2012 level. Looking to the future, we understand that the opportunities that lie ahead with respect to methane emissions reductions are limitless, and it is our responsibility to collaborate with all our stakeholders and usher in a new era of innovation.

INTRODUCTION

Global Methane Emissions

To date, most global efforts to reduce GHG emissions have been focused on carbon dioxide. As methane is odorless and colorless, this greenhouse gas has remained out of sight and 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.

An analysis of satellite imagery data by Kayrros, and others provided a clear image of global methane emissions "hot spots" from oil and gas operations, indicating that most emissions were from the Middle East, Russia, some African countries, and the US. In comparison, Canada's methane emissions from hot spots, as the fifth largest oil and gas producers in the world, are small.

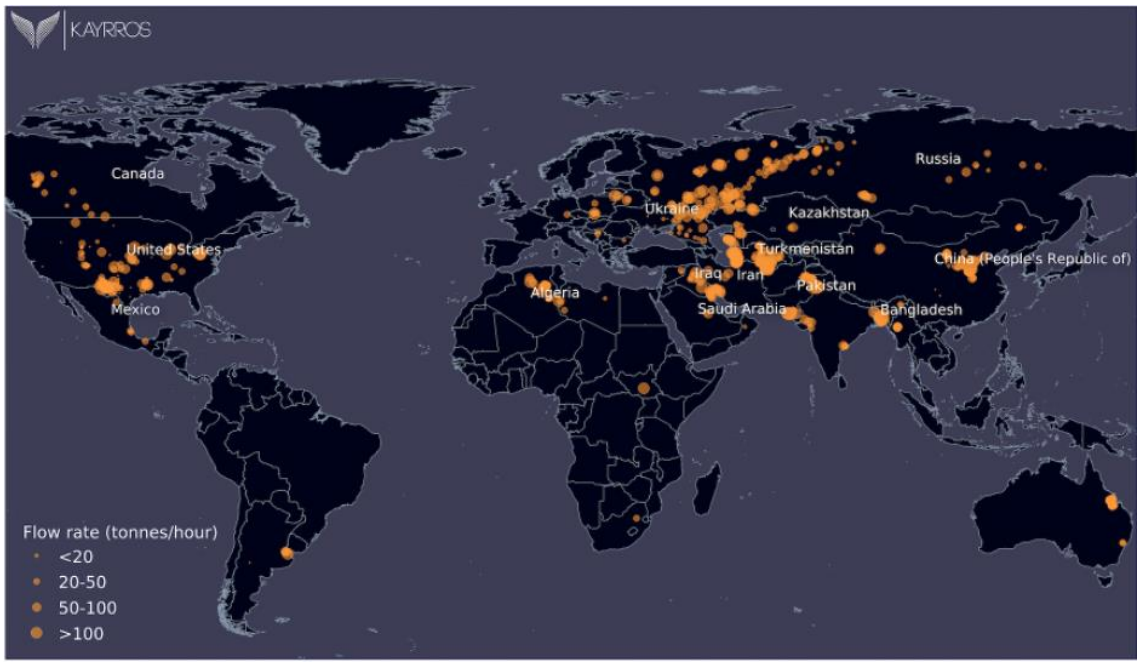

Figure 1: Global Methane Source Distribution

Image Credit: Kayrros

Globally, methane is the second largest greenhouse gas. The 580 Mt of annual global methane emissions reported by the International Energy Agency (IEA) in recent years indicate that approximately 40% of emissions are derived from natural sources, 25% from agriculture, 23% from oil and gas, and the remainder from landfills, and other sources. Clearly, as we are using more accurate tools, reducing methane emissions from some sources, finding new sources, the picture of the total emissions and emissions from each source is changing.

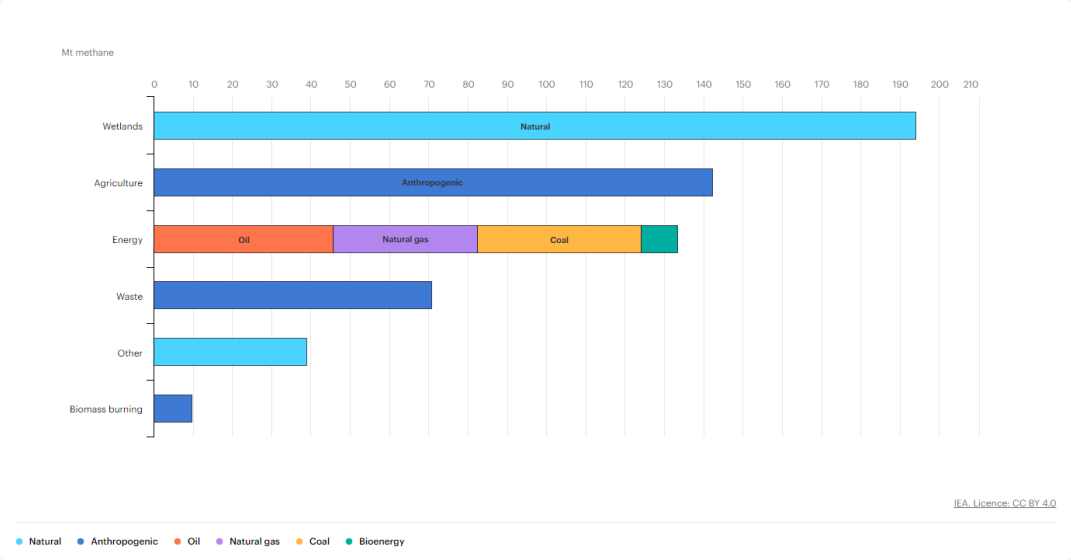

Figure 2: Sources of Methane Emissions (2023)

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 CO_2 (12 years in comparison to centuries), it is by far a more potent GHG. To estimate methane's effect on global warming, the most used method is the Global Warming Potential

(GWP). This method expresses one tonne of GHGs emitted in CO_2 equivalent terms to provide a single measure of the total GHG emissions.

The GWP method considers one tonne of methane to be equivalent to 28-36 tonnes of CO_2 if looking at its impact over 100 years, and 84-87 tonnes when considered over 20 years[1]. The Intergovernmental Panel on Climate Change (IPCC) has stated that the next 10 years will be the most crucial in controlling climate change.

A breakdown of Canada's GHG emissions in terms of CO_2e is shown in the Figure 2 below. Oil and gas emissions accounts for 27% of Canada's total emissions.

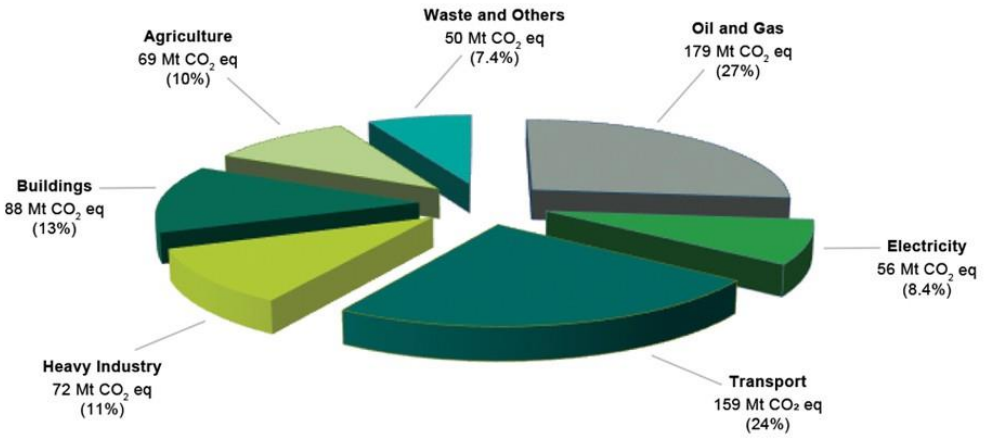

Figure 3: Breakdown of Canada's GHG Emissions by Economic Sector (2020)

Image Credit: Government of Canada - Greenhouse Gas Sources and Sinks in Canada: Executive Summary 2022

To further breakdown the 27% of GHG contributions the oil and gas sector contributes to Canada's emissions totals, various hydrocarbon types are illustrated in Figure 4.

[1] IEA, Methane Tracker 2020, IEA, Paris 2020, https://www.iea.org/reports/methane-tracker-2020

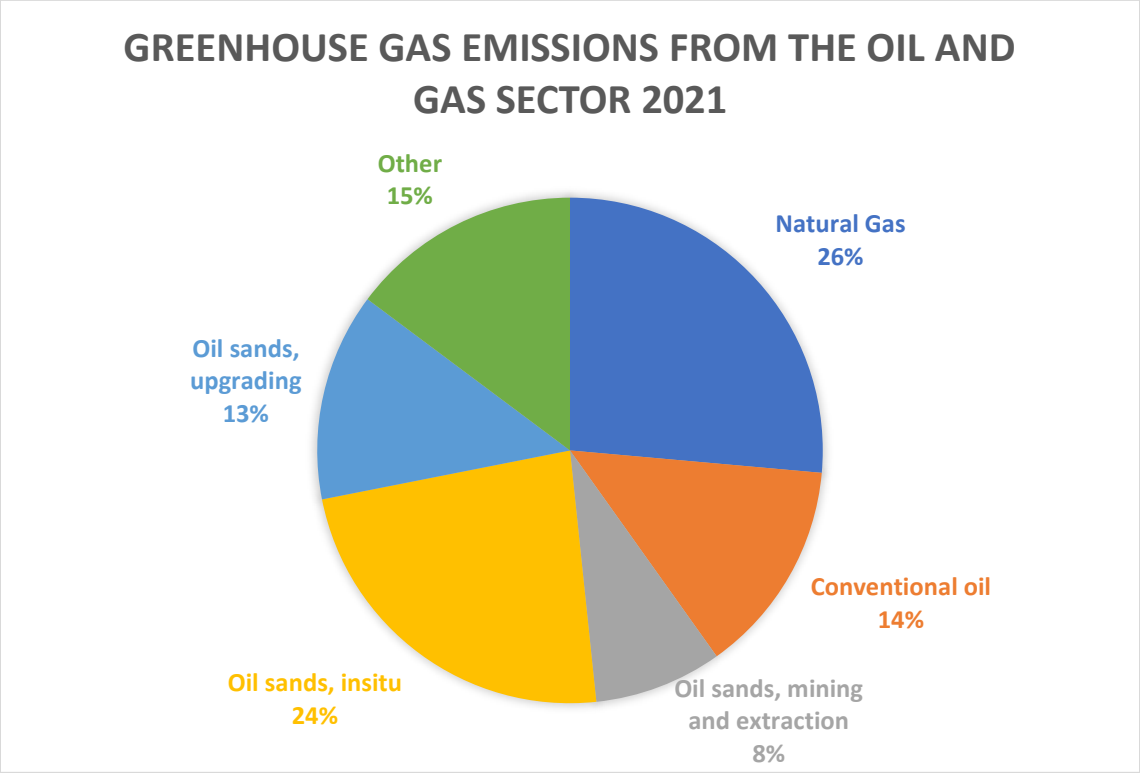

Figure 4: Greenhouse gas emissions from the oil and gas sector 2021

Data Credit: Government of Canada - Oil and gas sector greenhouse gas emissions, Canada, 1990 to 2021

Methane is also associated with volatile organic compounds, and is an ingredient found in the formation of ozone pockets. Clearly, light hydrocarbons vented from oil and gas operations affect not only our environment, but also our health. We understand that reducing methane emissions provides tremendous health, environmental and economic benefits, and is also a massive opportunity that we 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 prosper nationally and internationally.

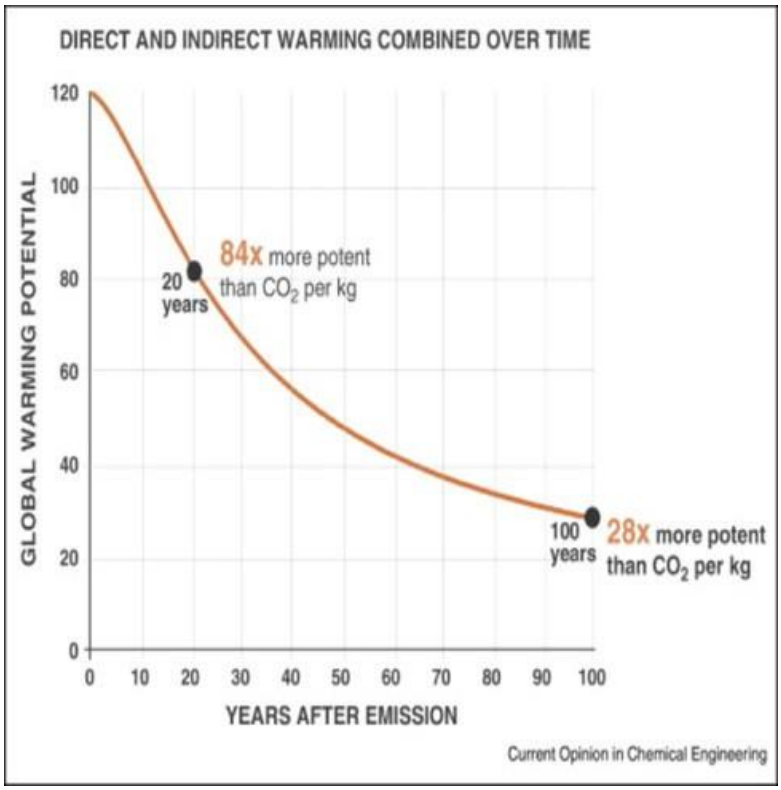

Figure 5: GHG Impact over Time

Image Credit: ResearchGate

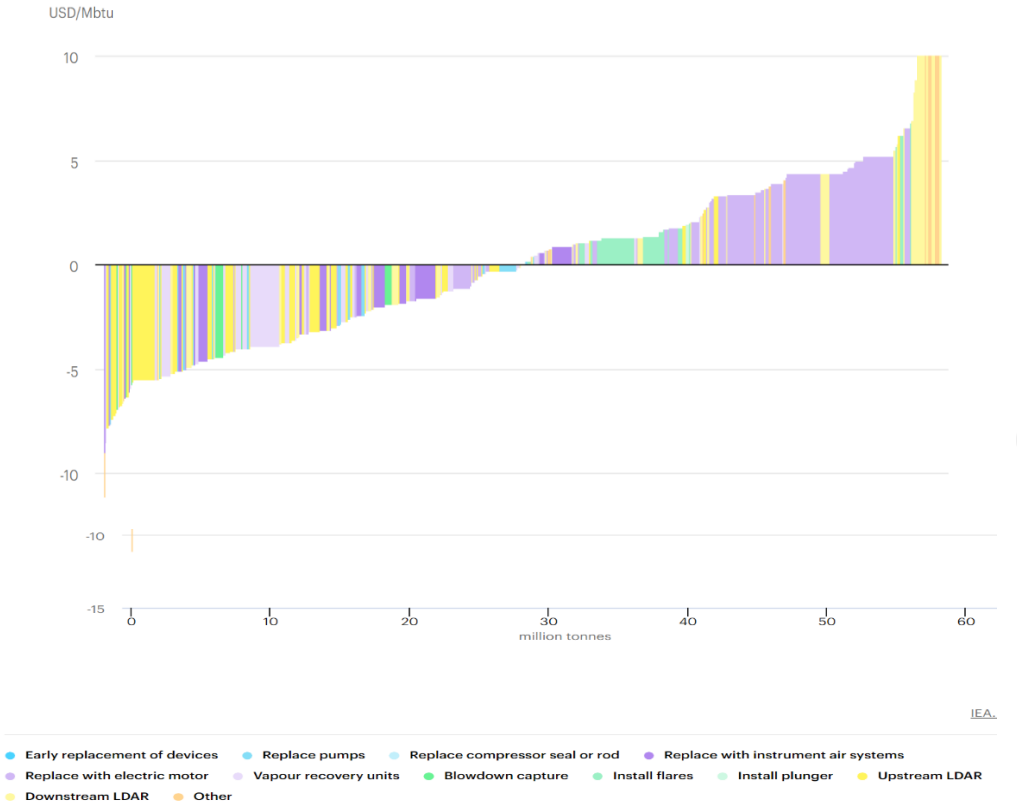

Figure 6: Marginal abatement cost curve for oil and gas methane emissions by mitigation measure, 2022

Image Credit: International Energy Agency

According to the IEA, with high natural gas prices in 2022, about 80% of the options to reduce methane missions from oil and gas operations worldwide could be implemented at no net cost[2].

In Canada, natural gas prices are less than natural gas prices in most countries; however, the combination of innovation, new technologies, regulations, and incentives have resulted in reducing methane emissions from the oil and gas sector by nearly 45% at present date. Recently, the Government of Alberta reported a 44% reduction of methane emissions from the oil and gas sector, making the 2025 federal and provincial target of 45% by 2025 attainable. However, higher natural gas prices may potentially result in higher natural gas production, hence higher emissions.

[2] IEA, Methane Tracker 2023, IEA, Paris 2023, https://www.iea.org/reports/global-methane-tracker-2023/overview

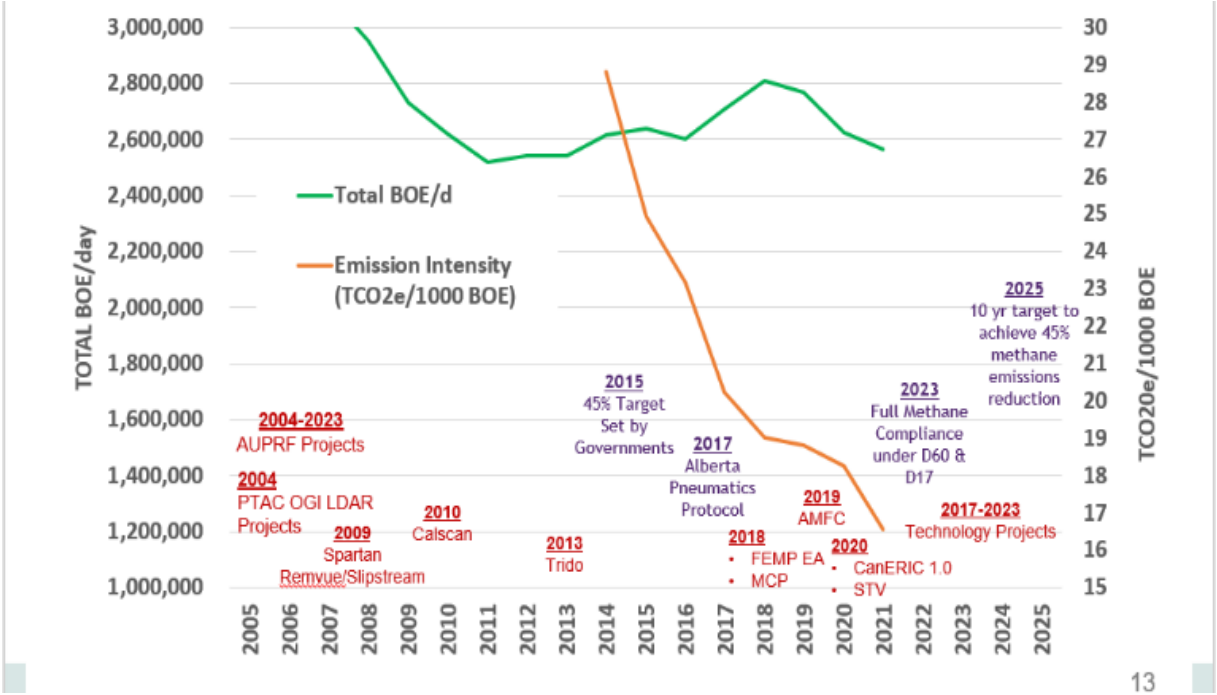

Figure 7: Methane Emissions Intensity and Corresponding PTAC Projects

Image Credit: PTAC

Since 2008, PTAC has been actively involved in addressing methane emissions in the oil and gas industry. The progress made in reducing methane emissions intensities is a direct result of the combined impacts of innovation, technologies, regulations, and policy incentives.

The deployment of new technologies, particularly those developed, demonstrated, and deployed through PTAC consortia such as Spartan REMVue (2009), Calscan (2010), and Trido (2013), has played a significant role in reducing methane emissions intensities, even prior to the implementation of key regulations such as the Alberta Pneumatics Protocol and the full Methane Compliance Directives, which came into effect several years later.

The data clearly indicates that our efforts have significantly contributed to the reduction of methane emissions intensities in the oil and gas industry. These achievements demonstrate the effectiveness of collaboration between industry, government, and research institutions in addressing environmental challenges and promoting sustainable practices.

Methane is the fastest, most cost-effective approach in reducing GHG emissions. The cost of carbon capture and storage (CCS) in reducing CO_2 starts at $50/ tonne and can increase to over $170/tonne. Conversely, methane reductions start at a negative cost and increase, for many technologies, to less than $10/tonne of CO_2 equivalent. Moreover, unlike CO_2, methane has commercial value; we can sell methane. Methane mitigation costs generally decrease as gas prices increase.

Natural gas is and will continue to play an important role in the energy system for many years to come. 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 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.

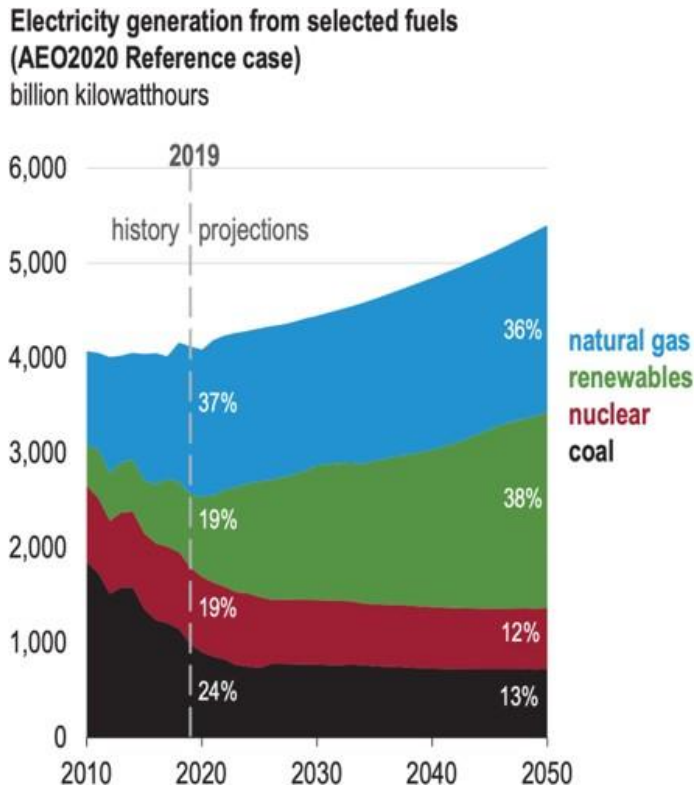

Figure 8: Electricity Generation from Selected Fuels

Image Credit: International Energy Agency

Electricity generation with the lowest carbon footprints from combustion of natural gas, CCUS, or hydrogen are essential for achieving net zero by 2050. This is attainable if we significantly reduce methane emissions from production, processing, and transportation of natural gas.

Methane reduction allows more natural gas to be delivered to customers while simultaneously improving our environment. Canada can play a major global leadership role in using methane to generate clean electricity and transportation, due to our current role as a global leader in CCUS, hydrogen, and methane detection/ mitigation technologies.

PTAC'S METHANE INNOVATION ECOSYTEM

PTAC Background

PTAC was formed 27 years ago to help improve the environmental, safety, and financial performance of the oil and gas industry through the facilitation and management of innovative and collaborative research and technology development initiatives.

PTAC has a diverse membership base, consisting of approximately 200 organizations. representing the clean tech industry, oil and gas producers, service and supply companies, governments, regulators, SMEs, R&D institutions, academia, and transporters.

Our consortia and technical steering committees benefit from the expertise of over 250 industry experts who serve as volunteers from member organizations. These experts play a crucial role in driving our projects forward.

Over the last 27 years, PTAC has successfully completed more than 800 projects. These projects contribute to the advancement of industry and address critical challenges.

PTAC has also organized and hosted over 1000 events to date. These events serve as platforms for the dissemination of outcomes from PTAC's consortia. Additionally, PTAC utilizes these events as a mechanism to share best practices, as well as the results of peer reviewed research, which is used by regulators and policy makers to develop smart policies and regulations.

PTAC also oversees the Alberta Upstream Petroleum Research Fund (AUPRF), which is supported by over 400 voluntary producer contributions every year. This fund plays a vital role in driving research and innovation within the Alberta upstream petroleum industry.

By fostering collaboration and innovation, we continue to play a significant role in advancing the oil and gas industry's environmental, safety, and financial performance.

Methane Reduction Initiatives

15 years ago, we started working on initiatives to reduce methane emissions by helping technology providers develop, field-test, demonstrate, and increase market uptake of their technologies. We later developed a technology roadmap which articulated the challenges technology providers faced in field testing and increasing market uptake of their technologies. In collaboration with producers, policy makers, and regulatory bodies, we crafted several obstacles related to methane emissions. Information was then crowdsourced and collected from a vast array of industry stakeholders. From this collaborative initiative, the following challenges were clearly identified:

- The methane ecosystem is fragmented and does not have effective coordination.
- Solutions that are available are not getting deployed quickly.

To address the first challenge in mending the fragmented innovation ecosystem, we created a unique innovation ecosystem that connects people, projects, organizations, capital, and ideas with the sole purpose of reducing methane emissions.

To close the gap of the second challenge, which aimed to fast-track market uptake of existing technologies developed and field tested through PTAC programs, two consortia were launched: the Systematic Third-party Validation of Environmental and Economic Performance of Methane Reduction Technologies (STV), and the Methane Consortia Program (MCP). These consortia 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, hence increasing market uptake.

The Methane Emissions Reduction Network (MERN)

The Methane Emissions Reduction Network is a one-stop-shop, launched in collaboration with the Clean Resource Innovation Network (CRIN) to connect people, projects, ideas, technologies, and capital within the methane reductions space. This network focuses on the development of bold and innovative applied research and technology development initiatives which support market-driven R&D projects to reduce methane emission

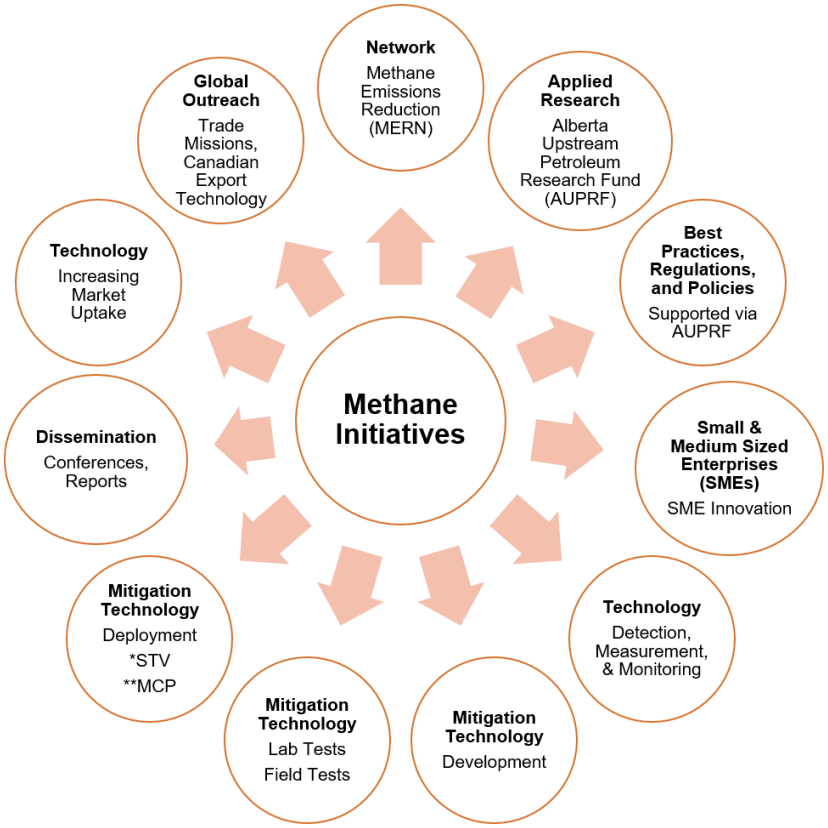

Figure 9: PTAC Methane Initiatives

Image Credit: PTAC Petroleum Technology Alliance Canada

Alberta Upstream Petroleum Research program fund Program (AUPRF)

The objectives of the AUPRF Program are to close the knowledge gaps, develop best practices while allowing the regulatory bodies and policy makers formulation of intelligent policies and regulations.

AUPRF Projects

Since the past 15 years, through massive collaboration among the Alberta Energy Regulator, the Alberta Environment and Protected Areas, and over 400 Alberta producers, PTAC has launched and completed over 500 applied research environmental management projects in five areas: Clean Air, Clean Water, Remediation, and Reclamations, Well Abonnement, and Ecology/Biodiversity. The focus of the Clean Air projects is to reduce GHG emissions (e.g., Methane, CO2, NOx, etc.). The goals of the AUPRF program are development of best practices for deployment by operators and information for the regulators, and policy makers to close the knowledge gaps for development of smart policies and regulations.

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

PTAC Best Management Practices:

- 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
- Pilot Measurements Study for Quantifying Methane Emissions at Upstream and Midstream Oil and Gas Facilities

PTAC Methane Applied Research & Studies:

- 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
- Chemical Cement Alternatives
- 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

In addition to the above applied research projects, the following three programs and additional detection surveys were launched under the AUPRF program.

Fugitive Emissions Management Program Effectiveness Assessment

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 several 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.

PTAC inevitably would like to have this data scoured for developing algorithms to obtain patterns that have not become apparent to us. This could lead to developing a predictive methane detection tool and identification of consistently leaking assets for design improvement.

Figure 10: Alberta Methane Field Challenge

Image Credit: University of Calgary

Alberta Methane Field Challenge

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 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. In addition, in the second trial, controlled release testing (CRT) was deployed at one site to provide calibration for QOGI and as a further comparative to other leak detection methods.

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.

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.

Figure 11: AMFC Field Work

Image Credit: PTAC

Alternative-Fugitive Emissions Management Program Project

The Alternative-Fugitive Emissions Management Program (Alt-FEMP) 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 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. 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

Our 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% by 2022 (achieved), and 90% by 2030 respectively.

PTAC Collective Technology Capacity Developed Through Technology Development

Over the past 15 years, PTAC, through the National Research Council – Industrial Research Assistance Program (NRC-IRAP), Alberta Innovates, Natural Resources Canada, and Emissions Reduction Alberta, has secured funds to help SMEs develop their technologies. The Methane Mitigation Technologies

Developed through PTAC collectively have the capacity to reduce oil and gas sector's methane emissions by 37% (see Figure 19).

PTAC Collective Technology Capacity Developed Through Field Tests

PTAC's field testing of SME's technologies have addressed the SME's biggest challenge, known as the valley of death. An example of one of the technologies commercialized through PTAC's 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 annually while reducing industry costs by $20 million per year. Even with this impressive performance, the uptake of this technology is low. The technology provider has declared that so far 7 million tonnes of cumulative CO_2e has been reduced through this technology.

Figure 12: RemVue Slipstream Technology

Image Credit: PTAC

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, now known as the Canadian Emissions Reduction Innovation Consortium (CanERIC).

A network of testing facilities, spanning from coast to coast was established through funding from Alberta Innovates and Natural Resources Canada.

Figure 13: Locations of Field Facilities, Labs & Organizations

Image Credit: PTAC

This consortium consists of a combination of 30 producers, universities, and research centres across Canada and the United States who have dedicated their field and lab facilities, 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 14: CanERIC Producer Members

Image Credit: PTAC

Figure 15: CanERIC Research Institution/Academia Members

Image Credit: PTAC

The Methane Mitigation Technologies Field Tested through PTAC collectively have the capacity to reduce the oil and gas sector's methane emissions by 39% (see Figure 19).

PTAC Collective Technology Capacity Developed Through Field Demonstration

These consortia aim to increase the investment in massive deployment of such technologies 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 CO2e/project (tCO2e)	Total GHG Reductions (tonne CO2)	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 16: 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 48% (see Figures 17, 18, and 19).

Sources of Methane Emissions	CH4 Emissions	CH4 Emissions	Technology Capacity**	Uptake of Technology by 2030***	Technology Capacity 2030
	MTCO2e / Year	(%)	%		%
Tanks	3.65	18.89	48.26	2.19	60
Engines	0.72	3.74		0.43	
SCVF	3.02	15.63		1.81	
Pneumatics	1.93	10.00		1.16	
Novel Pneumatics	5.39	28.00		3.24	
Fugitive Emissions	2.94	15.23		1.77	
Other*	1.67	8.64		1.00	
Total	**19.32**			**11.59**	

*See Other Sources in Figure 18

**Uptake by 2030 is assumed to be 60% of capacity

***Technology capacity built through PTAC's Consortia

Figure 17: Sources of Methane Emissions and PTAC Technology Capacity

Data Credit: Johnson and Tyner. PTAC.

Other Sources*	CH4 Emissions (%)
Compressor Seals	1.03
Compressor Starts	0.35
Glycol Dehys	0.28
Accidental Venting	0.00
Combustion	0.00
Flaring	0.00
Unloading/Loading	0.01
Sub Total	1.67

Figure 18: Other Sources of Methane Emissions

Data Credit: Johnson and Tyner

Technology Gaps	Technology Model Examples	Developed	Field Tested	Deployed/ Demonstrated
Controllers		✓	✓	✓
Instrument Gas to Instrument Air (single wells) - Credit	LCO Instrument Air	✓	✓	✓
Instrument Gas to Instrument Air (larger sites) - Credit	Trido Instrument Air	✓	✓	✓
Smart Pumps - Credit	MCI Chemical Pumps	✓	✓	✓
Smart Pumps - Credit	Sirius Chemical Pump	✓	✓	✓
Pump Optimization - Non-Credit	Texsteam Chemical Pump			✓
Pump STD Electric - Credit	Blue Source Low Bleed Chemical Pump		✓	
Shape Alloy Technology	Electric Dump Valve Actuator	✓		
Other		✓		
Engine: SlipStream	Analysis and Report of SlipStream® GTS-DeHy Auxiliary Burner System in Glycol Dehydration Units (2016), The REMVue® AFR and SlipStream® Technology – By Spartan Controls		✓	✓
Engine: REMVue	REMVue, The REMVue® AFR and SlipStream® Technology – By Spartan Controls, Field Evaluation of the REMVue Low Horsepower (LHP) Technology		✓	✓
Compression	Ironline			
Site Electrification - credit	Calscan Electric Wellsite	✓	✓	
Combustors	PureJet Combustor, Clear Rush Combustor, The LP Vapour Combustor – By Black Gold Rush Industries Ltd	✓	✓	✓
Flaring				✓
Modern Wellbore	Multilateral Junction by Modern Wellbore		✓	
Zero Emission Wellsites	Zero Emissions Wellsite – Demonstration of New Technology by Trido Industries for Eliminating Emissions at Remote Well Sites, Zero Emissions Wellsite by Cenovus, Zero Emissions Wellsite – BP Canada Validation of Sun Pumper versus Tex Steam Units		✓	✓
Vapour Recovery	Gas Pro Vapour Recovery Unit Evaluation Study (2016-2017)		✓	
General	Heavy Oil Emissions EcoEII		✓	
	(EGAS) Beam Compressor for Production Casing Gas		✓	✓
Measurement	Low Rate Flow Meters (Cenovus/Bonavista), PHI		✓	✓
Measurement	Low Rate Flow Meters (Cenovus/Bonavista), PHII		✓	✓

Combustors	TCE Combustors and Compressor Seals		✓	✓
	(XFER) 3 Phase Pump		✓	✓
Instrument Air, Electric Heaters	ZE Site	✓	✓	✓
Combustors	TCE Pipeline Blowdown Incineration		✓	✓
Dry Gas Seal	TCE DGS Project	✓	✓	✓
Measurement	Methane Slip (Accurata)		✓	✓
Measurement	Energy Use at CNRL Zero Emissions Site		✓	✓
Instrument Air/Power	Electrical Generation PH III Project		✓	✓
Combustors	Clean Combustion PH II Project		✓	✓
Combustors	METAN Deployment PH II Project	✓	✓	✓
Combustors	Catalytic Combustion (METAN) PHI	✓	✓	✓
N2	Pneumatics Test with Alternative Gas (Greenfield)		✓	✓
N2	Pneumatics Test with Alternative Gas (Brownfield)		✓	✓
Instrument Air/Power	Electrical Showdown PH II ATCO		✓	✓
Measurement	Tank Vent Study – MWA		✓	✓
Measurement	Tank Vent Study – Carleton		✓	✓
Measurement	MWA Understanding Tank Vent Emissions 2.0		✓	✓
PVRV	Controlled Tank Investigations (Spartan)		✓	✓
	Technology Capacity	**37%**	**39%**	**48%**

Figure 19: Methane Mitigation Technology Projects Developed, Field Tested, and/or Deployed/Demonstrated through PTAC

Image Credit: PTAC

Facing SMEs' Market Uptake Challenge

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

To attempt to mitigate this challenge, we 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, 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 Canadian cleantech companies looking to bring their methane technologies to international markets. Last year alone, PTAC completed 55 assessments with financial assistance from NRC-IRAP and launched 20 consortia to help SMEs achieve economic prosperity.

In the coming year, PTAC will also 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.

Please note that additional information regarding the technologies discussed in this paper can be found in Appendix A of this report.

Next Steps

Our target is to increase the technology capacity for reducing methane emissions from 48% to 75% using our existing and future consortia within the next three years. This is a tall order as we must deal with significantly more challenging sources of methane emissions:

- Tanks
- Emissions from CHOPS Wellsite
- Methane Slip from Engines
- Surface Casing Vent Flow
- Catalytic Heathers
- Flaring
- Combustors with significantly less emissions

CONCLUSION

In closing, reducing methane emissions requires collaborative innovation on a global scale. In understanding this need for mass collaboration, we have prioritized addressing the significant

challenges facing the Canadian oil and gas sector with respect to achieving methane emissions reduction targets and provides a platform where stakeholders can not only share their knowledge and work together, but also help influence change. We are stronger together than we are apart, and it is this underlying sentiment that has allowed PTAC to achieve so much over its nearly 30-year history.

APPENDICES

Appendix A – Project/Technology Descriptions

AirTek Systems

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. www.airteksystems.com/aurora-2-2

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

The SlipStream® GTS-DeHy system collects vented gases on glycol dehydrators and uses it for fuel. The system can be used by Operators to virtually eliminate the BTEX vented emissions from Glycol dehydrators.

Blue Source Low Bleed Chemical Pump (MCP)

This project identifies potential methane emission reductions evident through optimization of stroke length and plunger size in Texsteam 5100 Series chemical pump configurations.

Bruin Electric Pumps

The Bruin electric pumps are solar powered pumps and AC electric pumps.

Calscan Bear Solar Electric Control System

The Bear Solar Electric Control System 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 with separators.

Catalytic Methane Abatement System (CMAS)

CMAS by ETTER Engineering uses a platinum-based catalyst to convert methane gas into CO2 and water vapor. Once powered up, the units an operate indefinitely without any on-site electrical power.

Clear Rush Enclosed Vapour Combustor

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

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. www.eagle-pc.com

Field Evaluation of the REMVue Low Horsepower (LHP) Technology

REMVue® LHP (low horsepower) technology provides a way to meet regulatory limits for turbocharged engines by means of lean combustion.

Gas Pro Vapour Recovery Unit Evaluation Study

See PTAC website: Report

Heavy Oil Emissions EcoEII

See NRCan website: Public Report

IJack, Beam Pump, EGAS

The EGAS casing gas compressor drives emission reduction at vented multi-well pads.

LCO Chemical Injection Pump

LCO Technologies CROSSFIRE Solar-powered Chemical Injection Pump is an ultra-low power device designed to reduce chemical costs, maintenance costs and methane emissions. It can replace up to four pneumatic pumps with one unit.

LCO Instrument Air Compressor

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.

LCO Vapor Recovery Unit (VRU)

The LCO Technologies CROSSFIRE Vapor Recovery Unit is an ultra-low power device that compresses tank vapors for utilization or conversion.

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

The LMT EDVA can replace pneumatic devices currently in use and provide an efficient and affordable alternative for new installations. Replacing pneumatic actuators with EDVAs eliminates associated methane emissions.

The LP Vapour Combustor – By Black Gold Rush Industries Ltd

The BGR Cube is a low-cost vapour combustor designed to destruct VOCs and BTEXs produced from casing gas, pneumatic devices, or storage tanks.

MCI Chemical Injection Pumps

MCI Chemical injection pumps are high-efficiency electric pumps that eliminate methane emissions.

Modernization of Waukesha Engines

Ember Resources worked with Ironline Compression to modernize a Waukesha Engine. The application of this technology reduces the carbon footprint, increases 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 that enables multiple lateral wells to be drilled and accessed from a single well pad reducing drilling and associated cost and emissions.

PureJet Combustor

The PureJet is a family of incinerators that apply patented aerospace technologies to efficient waste gas destruction. PureJet is designed to integrate into existing facilities for ease of deployment and ability to tie into existing infrastructure.

Qnergy Remote Power and Instrument Air

The Qnergy solution is an engineered solution to replace methane emissions at gas wellsites with compressed air, powered by the Qnergy PowerGen.

The REMVue® AFR and SlipStream® Technology

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 to work in conjunction with SlipStream® vent capture. SlipStream® utilizes vented hydrocarbons that would otherwise be lost to the atmosphere, as a supplementary fuel source for natural gas engines.

Sirius Chemical Injection Pump

Sirius is making solar-powered chemical injection pumps practical and economical. Sirius solar pumps can replace up to 15 pneumatic pumps on a site with one pump.

Smart Tank Pressure Control Equipment to Monitor and Minimize Emissions from Controlled Production Tanks

The smart tank pressure control equipment to monitor and minimize emissions from controlled production tanks. Pressure control equipment and monitoring instrumentation is sized, selected, and tuned to work in conjunction with the vapor recovery system and is fit-for-purpose.

Texsteam Chemical Pump

Texsteam chemical pumps 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.

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 emission free well site. This simple design combines cutting-edge motor technology with the TRIDO VFD Controller.

Ventsentinel Flow Metering

The methane quantification meter by Ventbuster Instruments is used to quantify compressor packing vents to help quantify (baseline) emissions and associated opportunity for generation of verified carbon credits.

Zero Emissions Wellsite by Cenovus (MCP)

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 – Methane Technologies Supported by PTAC

Methane Technologies Supported by PTAC					Without Repetition
Mitigation Technology	**Vendor**	**Developed**	**Field Tested**	**Deployed**	
STV					
Instrument air - air flow meter	Fox thermal (Spartan)		X	X	X
Instrument air - air flow meter	Veriflow		X	X	X
Instrument air - electricity meter	Techmation		X	X	X
Instrument air - grid-powered	Eagle FS Curtis Rotary Screw		X	X	X
Chemical pump - grid-powered	LCO (Spartan)	X	X	X	X
Chemical pump -solar; three heads	LCO (Spartan)	X	X	X	X
Chemical pump - solar; single head	MCI		X	X	X
Chemical pump - solar; dual head	MCI		X	X	X
Chemical pump - grid-powered	Sirius		X	X	X
Chemical pump - grid-powered	Texsteam		X	X	X
Site electrification	Calscan	X	X	X	X
Instrument air	Trido	X	X	X	X
Chemical pump - solar; single head	Trido	X	X	X	X
Chemical pump - solar; dual heads	Trido		X	X	X
Instrument air/power generator	Westgen	X	X	X	X
Instrument Air	Cream Energy		X	X	X
Instrument air/power generator	Quincey/Simson-Maxwell		X	X	X
Instrument air	Chamco Sullair ES6-5XH		X	X	X
Combustor - BG36	Clear Rush	X	X	X	X
Chemical pump	NAB		X	X	X
Instrument air/power generator	OilPro Qnergy PowerGen		X	X	X
MCP					
Site electrification	Calscan				

Chemical pump - solar	Flomore Ecoflo35 (Cenovus)			X	X
Instrument air	Trido		X	X	
Chemical pump -solar	LCO (Spartan)	X	X	X	X
Instrument air/power generator	OilPro Qnergy PowerGen			X	
Engine modernization	Waukesha			X	X
Chemical pump	Spartan LCO	X	X	X	
Instrument air	Spartan LCO	X	X	X	X
Pneumatic pump retrofits	Blue Source		X	X	X
Chemical pump - grid-powered; single head	Texsteam (NAL)		X	X	
Chemical pump - grid-powered; dual head	Sirius (NAL)		X	X	
Chemical pump - grid-powered; three heads	Sirius (NAL)		X	X	X
Chemical pump -solar	AirTech Systems		X	X	X
CanERIC					
EGAS	IJACK Technologies		X	X	X
XFER	IJACK Technologies		X	X	X
Methane compressor	LCO (Spartan)	X	X	X	X
Catalytic converter	Etter Engineering and Metan Group		X		X
Enclosed combustor	Total Combustion Inc.		X	X	X
Smart pressure vacuum relief valve	Spartan Controls		X	X	X
Pressure sensing ring and wired pressure transmitter	Spartan Controls		X	X	X
Wireless limit switches and monitoring	Spartan Controls		X	X	X
Enardo thief hatch	Spartan Controls		X	X	X
Enclosed combustor	Emissions Rx			X	X
Enclosed combustor - Cube 500 and 1000	Clear Rush	X	X	X	X
Incinerator	Questor			X	X
Nitrogen gas for pneumatics	Kathairos			X	X
Power generation - internal combustion engine	Westgen	X	X		X
Power generation - Stirling engine	OilPro Qnergy PowerGen		X		X
Power generation - internal combustion engine	Global Power Technologies M1.5 and M5		X		X
Power generation - microturbine	Horizon Power Systems Capstone C65		X		X
Power generation - internal combustion engine	AISIN COREMO unit from ATCO		X		X
Booster Compressor skid for centrifugal compressor dry gas seals	by TC Energy		X		X
Other Projects					
EDVA	Linear Motion Technologies	X	X		X
PureJet combustors	Atlantis Reserch Labs	X	X		X

Multi-lateral junction	Modern Wellbore	X			X
Slipstream	REM Technologies	X	X	X	X
Slipstream GTS	REM Technologies	X			X
Vapor recovery unit for dehys	Gas Pro	X	X		X
Chemical pump -solar	Sun Pumper		X	X	X
AUPRF					
Enclosed combustor - BGR 36	Black Gold Rush		X		
Oxiperator	Prabu Labs	X			X
Biocover Concept for Leaking Wells	Millennium EMS Solutions Ltd. (MEMS) with CNRL	X			X
Detection and Quantification Technology	**Vendor**	**Developed**	**Field Tested**	**Deployed**	
AUPRF					
Sensors on drones	SeekOps		X		X
Sensors on drones	Heath Consultants		X		X
Sensors on drones	Aerometrix		X		X
Sensors on trucks	Altus Technologies		X		X
Sensors on trucks	Heath Consultants		X		X
Sensors on trucks (Pomelo)	University of Calgary		X		X
Sensors on crewed aircraft	Bridger Photonics		X		X
Sensors on crewed aircraft	Sander Geophysics		X		X
Hand-held camera	FLIR		X		X
Hand-held sensor	Tecvalco		X		X
Ground-based sensor	Luxmux		X		X
Sensors on crewed aircraft SWIR HS imaging	GHGSat		X		X
Truck-mounted TDLAS	Boreal Laser		X		X
Drone-mounted TDLAS (tuneable diode laser absorption spectroscopy)	SAIT		X		X
QOGI: GF320/QL320	FLIR QOGI		X		X
Airborne Gas Mapping LiDAR (GML) sensor	Bridger Photonics		X		
Sensors on drones	GE - UAV		X		X
Ground-based sensor	GE - Sentry		X		X
NASA's Open Path Laser Spectrometer (OPLS) mounted on drone	SAIT	X			X
Hand-held sensor	Sonoma Technology		X		X
Other Projects					
LDAR Sims software	University of Calgary	X	X		X
IM3S software	University of Calgary	X	X		X
Reduction Pathways software	Highwood Emissions Management	X	X		X
PEMS software	VL Energy	X			X
Truck-mounted sensors	mAIRSure	X	X		X

Distributed Energy Efficiency Project Platform (DEEPP) software	CapOp Energy	X	X		X
Methane Abatement Platform software	CapOp Energy	X	X		X
Sensors on drones	GE - UAV		X		
Ground-based sensor	GE - Sentry		X		
Sensors on drones	University of Calgary		X		X
Methane Advisor software	Process Ecology		X	X	X
AUPRF and CanERIC					
Sensors on crewed aircraft	LiDAR Services International and Telops		X	X	X
Ventx	Carleton University				X
CanERIC					
Ground-based sensor	Kuva Systems		X	X	X
Methane emissions analytics software	Arolytics		X	X	X
VentSentinel	Vent Busters		X		X
	Total	**29**	**85**	**51**	**89**

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

Appendix D – Acknowledgments

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In addition, PTAC would like to extend its appreciation to the following organizations, and individuals for providing funding, volunteer dedication, and outstanding expertise - PTAC could not have accomplished any of this work without your hard work and unwavering support.

Air Research Planning Committee (ARPC)

The 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. ARPC's 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

- Moruf Aminu, Encana
- Jacob Bayda, Saskatchewan Ministry of Energy and Resources
- James Beck, Suncor
- Andrew Cattran, NuVista Energy
- Randy Dobko, Alberta Environment and Protected Areas (AEPA)
- Colin Hennel, Bonavista Energy
- Sean Hiebert, Cenovus
- Yaomin Jin, BC Oil and Gas Commission
- Peter Kos, BC Oil and Gas Commission
- Neuczki Mathurin, TC Energy
- Don McCrimmon, Canadian Association of Petroleum Producers (CAPP)
- Graham Noble, Saskatchewan Ministry of Energy and Resources
- Filiz Onder, Ovintiv
- Koray Onder, TC Energy
- Gerald Palanca, Alberta Energy Regulator
- Sean Smith, Environment and Climate Change Canada (ECCC)
- Carolyn Ussher, Alberta Energy Regulator
- Andrea Zabloski, Canadian Natural Resources

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 is 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:

- Jim Brydie, CanmetENERGY-Devon
- Kyle Daun, University of Waterloo, Flarenet
- Bob Davies, SAIT
- Erica Emery, Saskatchewan Research Council
- Matt Johnson, Carleton, FlareNet
- Nader Mahinpey University of Calgary
- Vita Martez, SAIT
- Scott Mundle, University of Windsor
- Jason Olfert, University of Alberta, FlareNet
- Kirk Osadetz, CMC
- Erin Powell, Saskatchewan Research Council
- David Risk, St. Francis Xavier University
- Xiaomeng Wang, CanmetENERGY-Devon
- Fred Wassmuth, Innotech Calgary
- Neil Yaremchuk, Innotech Vegreville

Industry Solutions Steering Committee Members:

- Brian Doucette, Suncor
- Kendell Esau, Bonavista
- Brandon Fong, TC Energy
- Tyler Homan, Teine Energy
- Michael Leung, ATCO
- Patrick Kitchen, Whitecap Resources
- Rob MacNutt, NuVista
- Neuczki Mathurin, TC Energy
- Eldon Siegle, Ovintiv
- Morgan Wrishko, Cenovus
- John Yakielashek, TC Energy
- Andrea Zabloski, Canadian Natural Resource.

CanERIC Producers

- ATCO
- Bonavista Energy
- Canadian Natural Resources
- Cenovus Energy
- Chevron
- NuVista Energy
- Ovintiv
- Suncor
- TC Energy
- Teine Energy
- Whitecap Resources

CanERIC Research Institutes/Academia

- CanmetENERGY
- Carleton University
- CMC Research Institutes
- InnoTech Alberta
- Saskatchewan Research Council
- Southern Alberta Institute of Technology
- St. Francis Xavier University
- University of Alberta
- University of Calgary
- University of Waterloo
- University of Windsor

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
- Thomas Fox, Highwood Environmental Management
- Claude Ghazar, Alberta Innovates
- Chris Hugenholtz, University of Calgary
- Jessica Shumlich, Highwood Environmental Management

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 methane innovation within the Alberta oil and gas sector.

Committee Members:

- Heather Carmichael, Alberta Environment and Protected Areas
- Chris Hugenholtz, University of Calgary
- Monica Micak, Alberta Environment and Parks
- 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 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
- Janelle Mravcak, Atlantis Research Labs
- Vladimir 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 of a cohort of technologies, allowing them to cross over the chasm that separates them from full commercialization.

Committee Members:

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

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 implementing new technologies and methods required to achieve air emissions reductions in the oil and gas industry. TEREE projects have made a significant contribution to industry through the transfer of technologies used globally in the sector.

Committee Members:

- Moruf Aminu, Ovintiv
- Joshua Anhalt, GreenPath Energy
- Brenna Barlow, BMO Radicle
- James Beck, Suncor
- Doug Bezpalko, Calscan
- Andrew Cattran, NuVista
- Mike D'Antoni, GreenPath Energy
- Don D'Souza, Government of British Columbia
- Yonathan Dattner, Luxmux Corporation
- Cam Dowler, Spartan Controls
- Bruce Duong, Alberta Innovates
- Krystina Edwards, Highwood Emissions Management
- Richelle Foster, Canadian Natural Resources
- Thomas Fox, Highwood Environmental Management
- Steve Froehler, LCO Technolgies
- Kevin Heal, BMO Radicle
- Owen Henshaw, Cenovus
- Sean Hiebert, Cenovus
- James Holoboff, Process Ecology
- Taryn Humpherys, Qube
- Roy Hunt, Advisian
- Mark Jamieson, Alberta Department of Energy
- Paul Jiapizian, Environment Canada
- Arvinder Kainth, NRC – IRAP
- Derek Kelly, Natural Resources Canada
- Patrick Kitchin, Whitecap Resources
- Milos Krnjaja, Alberta Energy Regulator
- Derek L'Hirondelle, SFC Energy Canada
- Ray Lambert, Cenovus
- Michael Lawson, Alberta Energy Regulator
- Logan Leduc, Environment Canada
- Dan Li, Crescent Point
- Neuczki Mathurin, TC Energy
- Andrew McClausland, BMO Radicle
- Andrew McDowell, LCO Technologies
- Brendan Moorehouse, Highwood Environmental Management
- Kelly Newnham, Advisian
- Graham Noble, Government of Saskatchewan
- Liz O'Connell, Arolytics
- Chelsea O'Connor, SFC Energy Canada
- Connor O'Shea, Westgen Technologies
- Koray Onder, TC Energy
- Hector Ortiz, Spartan Controls
- Kirk Osadetz, CMC Research Institutes
- Gerald Palanca, Alberta Energy Regulator
- Olivia Petrus, Spartan Controls
- Carolyn Pfau, Alberta Energy Regulator
- Rao Ravi, Spartan Controls
- Cooper Robinson, BMO Radicle
- Cam Rollins, Arolytics
- Dallas Rosevear, Clear Rush
- Jessica Schumlich, Highwood Environmental Management
- Monica Sippola, Kuva Systems
- Scott Smith, Cenovus Energy
- Lisa Studzinski, Enerplus
- Mark Summers, Emissions Reduction Alberta
- Greg Unrau, Repsol
- Dani Urton, Vertex
- Brian Van Vliet, Spartan Controls
- Charles Ward, Alberta Department of Energy
- Morgan Wrishko, Cenovus
- Kourosh Zanganeh, Natural Resources Canada

Funding Organizations

- Alberta Innovates
- Emissions Reduction Alberta
- Global Affairs Canada Trade Commissioner Service
- National Research Council of Canada's Industrial Research Assistance Program
- 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 Technologie