OIL AND GAS METHANE DETECTION,

Soheil Asgarpour, Ph.D., FCAE, FCIM, FCSSE, P. Eng.
PTAC CEO & President
<table>
<thead>
<tr>
<th></th>
<th>Methane Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mass Spectrometer (Deep Carbon Observatory)</td>
</tr>
<tr>
<td>2</td>
<td>U10 Laser Methane Leakage Detector</td>
</tr>
<tr>
<td>3</td>
<td>FTIR Spectrometer</td>
</tr>
<tr>
<td>4</td>
<td>Silicon Photonic Absorption Spectrometer</td>
</tr>
<tr>
<td>5</td>
<td>Methane detection from drone</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Provider</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Deep Carbon Observatory</td>
</tr>
<tr>
<td>2</td>
<td>Aeromotus</td>
</tr>
<tr>
<td>3</td>
<td>Telops</td>
</tr>
<tr>
<td>4</td>
<td>JWN Energy</td>
</tr>
<tr>
<td>5</td>
<td>ArchAerial</td>
</tr>
</tbody>
</table>
Surveillance: methane emission 'hot spots' are visible in a map created using satellite imagery and other data sources.
Sources of methane emissions
Methane Tracker 2021

MT of methane

- **Wetlands**
  - Natural

- **Agriculture**
  - Anthropogenic

- **Energy**
  - Bioenergy
  - Oil
  - Coal
  - Gas

- **Waste**
  - Anthropogenic

- **Other**
  - Natural

- **Biomass burning**
  - Natural

Image credit: IEA
Figure ES-7 Breakdown of Canada’s GHG Emissions by Economic Sector (2019)

- Agriculture: 73 Mt CO₂ eq (10%)
- Waste and Others: 51 Mt CO₂ eq (7.0%)
- Oil and Gas: 191 Mt CO₂ eq (26%)
-Electricity: 61 Mt CO₂ eq (8.4%)
-Transport: 186 Mt CO₂ eq (25%)
-Heavy Industry: 77 Mt CO₂ eq (11%)
-Buildings: 91 Mt CO₂ eq (12%)

Total: 730 Mt CO₂ eq

Note: Totals may not add up due to rounding.
Breakdown of Canada's GHG Emission Contribution by Oil & Gas (2019)

- Oil, NG & CO2 Transmission: 6%
- Downstream O&G: 10%
- Oil Sands Upgrading: 13%
- Oil Sands In-situ: 22%
- Oil Sands Mining and Extraction: 8%
- Total Upstream Conventional: 28% - 78 MtCO2e

Total: 192.2 MtCO2e

Source: NATIONAL INVENTORY REPORT 1990 –2019: GREENHOUSE GAS SOURCES AND SINKS IN CANADA
Methane Emissions Challenges

*2018 DATA BY SUBCATEGORY*

- Flaring: 1%
- Stationary Combustion: 1%
- Fugitive - Equip Leak (NonDetect): 5%
- Fugitive - Equip Leak (Detected): 10%
- Vent - Petrinex: 15%
- Vent - Pneumatic Pumps: 17%
- Fugitive - SCVF: 17%
- Vent - Pneumatic Instruments: 22%
- Fugitive - GM, RUPT, SPILL: 1%
- Vent - Dehy, Compressor Start & Truck Loading: 1%
- Vent - Tanks: 4%
- Vent - Compressor Seals: 6%

Image credit: PTAC
Methane and Climate Change
DID YOU KNOW ...

Canada’s Oil & Gas Industry is ALSO Canada’s Largest Cleantech Industry?
PTAC’s Methane detection and mitigation

Grand Vision

Methane Mitigation:

• To increase methane mitigation technology capacity by 45% by 2022 at a cost of less than $5 per tonne of carbon dioxide equivalent (CO$_2$e). 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.
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 (2015)

- Improved Flare Source Parameters for CALPUFF and AERMOD Dispersion Models (2015)

- Leak Detection and Repair Baseline (2016)

- Vehicle-based Fugitive Emission Detection and Attribution within Albert Energy Developments (2016)

- Mitigating Low Volume Methane Emissions (2016)

- Pneumatic Vent Gas Measurement (2017)

- Verification of Quantitative Optical Gas Imaging System (2017)

- Pilot Measurements Study for Quantifying Methane Emissions at Upstream and Midstream Oil and Gas Facilities (2017)
Methane Applied Research and Studies

- Identification and Evaluation of GHG Reduction & Energy Efficiency Improvement Opportunities at Oil and Gas Facilities (2008)
- Emissions Reduction opportunities in Dehydration Facilities
- Validation of Reduced Spacing from Residences for Enclosed Combustors
- Mitigating low volume methane emissions - Erica Emery, Saskatchewan Research Council
- Field Data Collection Study to Investigate Abnormal Tank Venting - Yori Jamin, Clearstone Engineering Ltd.
- Stationary Engines Air Emissions Research (2012)
- Petroleum Emissions Management Accelerator (PEMA) – Study of the Potential for Emissions Reductions in Conventional Oil and Gas (2013)
- Conceptual Engineering Study of Technologies for Reducing Methane Venting in Cold Heavy Oil Production (2015)
- REMVue Slipstream Industry Impact Assessment
Fugitive Emissions Management Program Effectiveness Assessment (FEMP EA)

- A world class methane detection, quantification and verification applied research project.
  - Study area = 2500 Square Kms
  - 200 facilities (a total of 30 operators).
  - 100% voluntary participation from operators.
  - 200 sites selected for leak detection and repair surveys using optical gas imaging, Hi-Flow sampler, and QOGI
Field Challenges

Alberta Methane Field Challenge

• Sought to understand the real-world performance of alternative methane leak detection technologies in comparison to conventional camera-based surveys..
  – 2500 square kilometer in the Rocky Mountain House Region
Field Challenges

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
List of 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)
List of 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)
2021/2022 Detection Projects

Understanding Routine and non-Routine Venting from Tanks

- Methods for Estimating Emissions from Tank
- Quantification of Transient Methane Venting through Fixed Roof Liquid Storage Tanks
- Measurement of Associated Gas and Venting Volumes at CHOPS Sites in Alberta and Saskatchewan

Evaluation of Alternative Detection and Quantification Technologies, and assess their ‘Equivalence’ to prescribed OGI LDAR:

- Evaluation of Current & Emerging Emission Quantification

Evaluation of Surface Casing Vent Flows at Inactive Wells: Database Analysis and Field Measurements in Alberta

State of Science on Emission Rate Thresholds for Upstream Petroleum IndustryLeaks Corresponding to a Range of ppm Concentration Thresholds.
Methane Mitigation Technologies Developed through PTAC

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

Source: NATIONAL INVENTORY REPORT 1990–2019: GREENHOUSE GAS SOURCES AND SINKS IN CANADA
REMVue Slipstream

Current Benefits
- 130,000/year cars off road
- $15 Million/year value creation

Full Industry Uptake
- 1.6 Million/year cars off the road
- $160 Million/year value creation

One example of many new PTAC technologies successfully delivering results.
Consortium of Methane Emission & Abatement Test Facilities
Locations of Field Facilities, Labs & Organizations

Alberta
- Calgary & Rural Alberta
  - ATCO
  - CAPP
  - Cenovus Energy
  - CMC Research Institutes
  - CRIN
  - Encana
  - Inter Pipeline
  - NAL Resources
  - Orphan Well Association
  - PTAC
  - SAIT
  - Seven Generations
  - TC Energy
  - TEREE
  - Total EP Canada
  - University of Calgary

Devon
- CanMET Energy

Edmonton
- ATCO
- University of Alberta

Fort McMurray
- Suncor
- Cenovus Energy
- Imperial Oil

Grand Prairie
- Seven Generations

Rainier
- CMC Research Institutes

Vegreville
- InnoTech Alberta

British Columbia
- Fort St. John
  - PETRONAS Canada

Northeast BC
- CNRL
- Encana
- Husky
- Imperial
- Suncor
- TC Energy

Northwest Territories
- Norman Wells
  - Imperial Oil

Newfoundland and Labrador
- St. John's
  - Husky Energy
  - Suncor

Nova Scotia
- Antigonish
  - St. Francis Xavier University

Quebec
- Montréal
  - TC Energy
  - Université de Montréal

Saskatchewan
- Regina and Saskatoon
  - SRC

Rural Saskatchewan
- CNRL
- Husky
- Inter Pipeline
- NAL Resources
- TC Energy
- Whitecap

Manitoba
- Rural Manitoba
  - CNRL
  - TC Energy

USA
- Colorado State University
  - Harrisburg University
- METEC
- TC Energy
- Total SA

Ontario
- Ottawa
  - Carleton University

Rural Ontario
- TC Energy

Waterloo
- University of Waterloo
Methane Mitigation Technologies Field Tested through PTAC

- 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
- Blue Source low bleed chemical pump
- REMVue
- Gas Pro Vapour Recovery Unit Evaluation Study (2016-2017)
- Heavy Oil Emissions EcoEII

Source: NATIONAL INVENTORY REPORT 1990 –2019: GREENHOUSE GAS SOURCES AND SINKS

PTAC Field Tested Case In Technology Abatement, %age Contribution

- Removed AER 23%
- Fugitive Emissions 10%
- Venting 17%
- Flaring 11%
- Removed PTAC 39%
<table>
<thead>
<tr>
<th>Project Lead</th>
<th>Project</th>
<th>Total Mitigated CO2e</th>
<th>Number of Installations</th>
<th>Total GHG Reductions (tonne CO2e)*</th>
<th>Potential for installation</th>
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<tbody>
<tr>
<td>CalScan</td>
<td>Site Electrification</td>
<td>1216</td>
<td>10</td>
<td>18240</td>
<td>5000</td>
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<tr>
<td>Cenovus</td>
<td>Facility of the Future including: electric instruments &amp; pumps, instrument air, and remote on-site power generation.</td>
<td>8658</td>
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<tr>
<td>Ember</td>
<td>Compressor Engines</td>
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<td>Spartan</td>
<td>Instrument Air Compressor</td>
<td>635</td>
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<td>Spartan LCO</td>
<td>Smart Pumps</td>
<td>2738.6</td>
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<td>STD Electric</td>
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<td>101</td>
<td>89586</td>
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Methane Mitigation Technologies/Projects
Deployed/Demonstrated through PTAC

- LCO Chemical Pump
- LCO Instrument Air
- Trido Chemical Pump
- Trido Instrument Air
- Air Teck Systems
- Ironline
- Texsteam Chemical Pump
- MCI Chemical Pumps
- Sirius Chemical Pump
- Eagle Power Supply
- Clear Rush Combustor
- The REMVue® AFR and SlipStream® 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

PTAC Deployed/Demonstrated Case In Technology Abatement, %age Contribution

- Removed AER 23%
- Fugitive Emissions 10%
- Venting 8%
- Flaring 11%
- Removed PTAC 48%

Source: NATIONAL INVENTORY REPORT 1990–2019: GREENHOUSE GAS SOURCES AND SINKS IN CANADA
## Canadian Capabilities

<table>
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<tr>
<th>Products</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion</td>
<td>99.9% efficient at converting methane</td>
</tr>
<tr>
<td>Compress Methane</td>
<td>Compress methane back into sales</td>
</tr>
<tr>
<td>Instrument Air</td>
<td>Compress air to deliver power to pneumatics</td>
</tr>
<tr>
<td>Chemical Pumps</td>
<td>Electrically powered pumps</td>
</tr>
<tr>
<td>Electric Devices</td>
<td>Replace pneumatically operated devices</td>
</tr>
<tr>
<td>Electricity Generation</td>
<td>Create electricity by burning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Services</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection, Measurement, Quantification, Monitoring</td>
<td>Supply services to detect and monitor emissions</td>
</tr>
<tr>
<td>Research</td>
<td>Research labs to validate equipment for service</td>
</tr>
<tr>
<td>Reporting</td>
<td>Generating reports for companies and government</td>
</tr>
<tr>
<td>Management</td>
<td>Overall management from measurement and reporting, to strategic methods of optimizing money spent on this challenge</td>
</tr>
<tr>
<td>New</td>
<td>Typically engineering</td>
</tr>
</tbody>
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Thank You!

For more Information please contact Soheil Asgarpour at sasgarpour@ptac.org