New Developments in Drones and Methane Detection for Monitoring, Emissions Detection, and Regulatory Compliance*

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Abstract

This presentation discusses the methane emissions detection, from the new Environmental Protection Agency rules which took effect in June 2016, the reporting and monitoring requirements, the locations where emissions monitoring is required, and the types of sensors that can be used. In addition, the presentation discusses how to go about planning drone flights, given the different types of installations to be monitored, and the legal restrictions in place.

Selected References

Berman, E.S.F.; M. Fladeland, J. Liem, R. K., and M. Gupta, 2012, Greenhouse gas analyzer for measurements of carbon dioxide, methane, and water vapor aboard an unmanned aerial vehicle: Sensors and Actuators B: Chemical, v. 169, 5 July 2012, Pages 128-135, ISSN 0925-4005. Website accessed February 13, 2017, http://dx.doi.org/10.1016/j.snb.2012.04.036.

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Environmental Protection Agency, June 3, 2016, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources; Final Rule. Federal Register. Website accessed February 13, 2017, https://www.gpo.gov/fdsys/pkg/FR-2016-06-03/pdf/2016-11971.pdf.

Pergam, 2015, UAV-mounted methane detector and companion data logger. Brochure.

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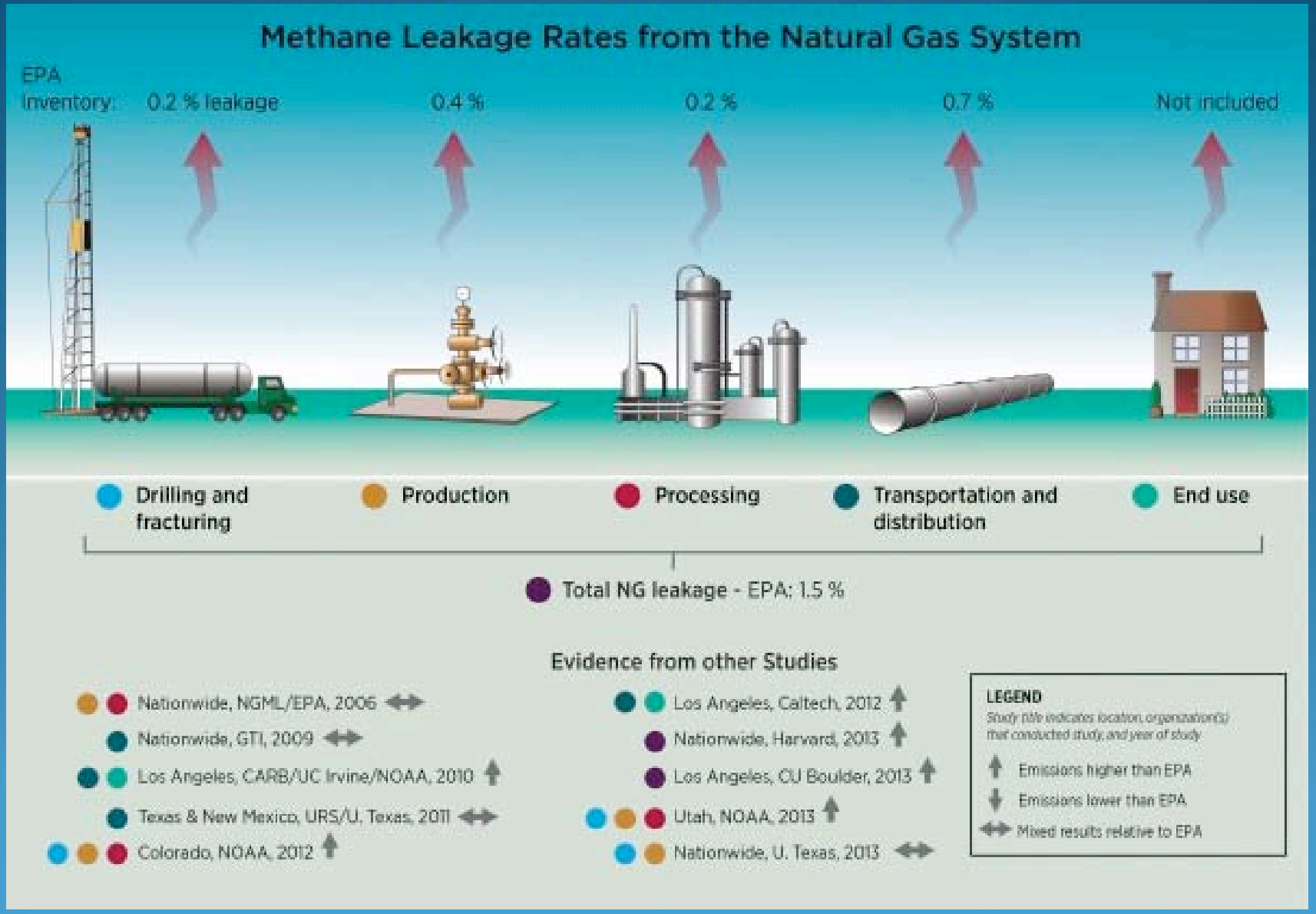
Recent Changes

- Methane emissions regulations for fugitive methane
- EPA, June 2016
- BLM, November 26
- Must develop plan and monitor
- Completions, gas processing, transportation


Methane Leakage Rates from the Natural Gas System
EPA Inventory: 0.2 % leakage
0.4 %
0.2 %
0.7 %
Not included
Drilling and fracturing
Production
Processing
Transportation and distribution
End use
Total NG leakage - EPA: 1.5 %
Evidence from other Studies
Nationwide, NGML/EPA, 2006
Nationwide, GTI, 2009
Los Angeles, CARB/UC Irvine/NOAA, 2010
Texas & New Mexico, URS/U. Texas, 2011
Colorado, NOAA, 2012
Los Angeles, Caltech, 2012
Nationwide, Harvard, 2013
Los Angeles, CU Boulder, 2013
Utah, NOAA, 2013
Nationwide, U. Texas, 2013
LEGEND
Study title indicates location, organization(s) that conducted study, and year of study
Emissions higher than EPA
Emissions lower than EPA
Mixed results relative to EPA

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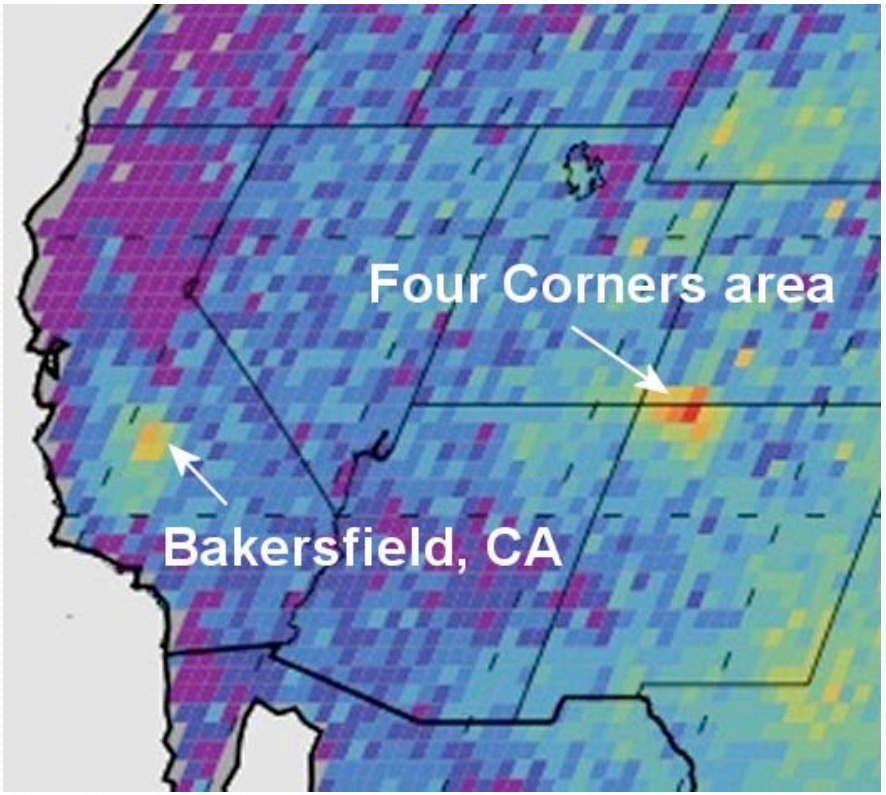
Four Corners Methane Hot Spot

According to the BLM, from 2009- 15, oil and gas producers on public lands vented, flared and leaked about 462 billion cubic feet (Bcf) of natural gas.



BLM Methane and Waste Prevention Rule

The Bureau of Land Management's new Methane and Waste Prevention Rule

- Cut flaring, venting and leaking at natural gas wells
- 44% over the next eight years.
- The rule will apply to all wells on federal and tribal lands.

EPA: Methane Emissions

- Oil and Natural Gas Sector: Emissions Standards for New, Reconstructed, and Modified Sources

- Effective August 2, 2016

Industries Affected

- NAICS code 211111: Crude petroleum and natural gas extraction
- NAICS code 211112: Natural gas liquid extraction
- NAICS code 221210: Natural gas distribution
- NAICS code 486110: Pipeline distribution of crude oil
- NAICS code 486210: Pipeline transportation of natural gas

- Wet seal centrifugal compressors (except those located at well sites)
- Reciprocating compressors (except those located at well sites)

Gas Gathering & Processing

- Pneumatic controllers at natural gas processing plants
- Pneumatic pumps at natural gas processing plants and well sites

Well Completions

- Hydraulic fracturing
- Stimulation
- Flowback
- Flares

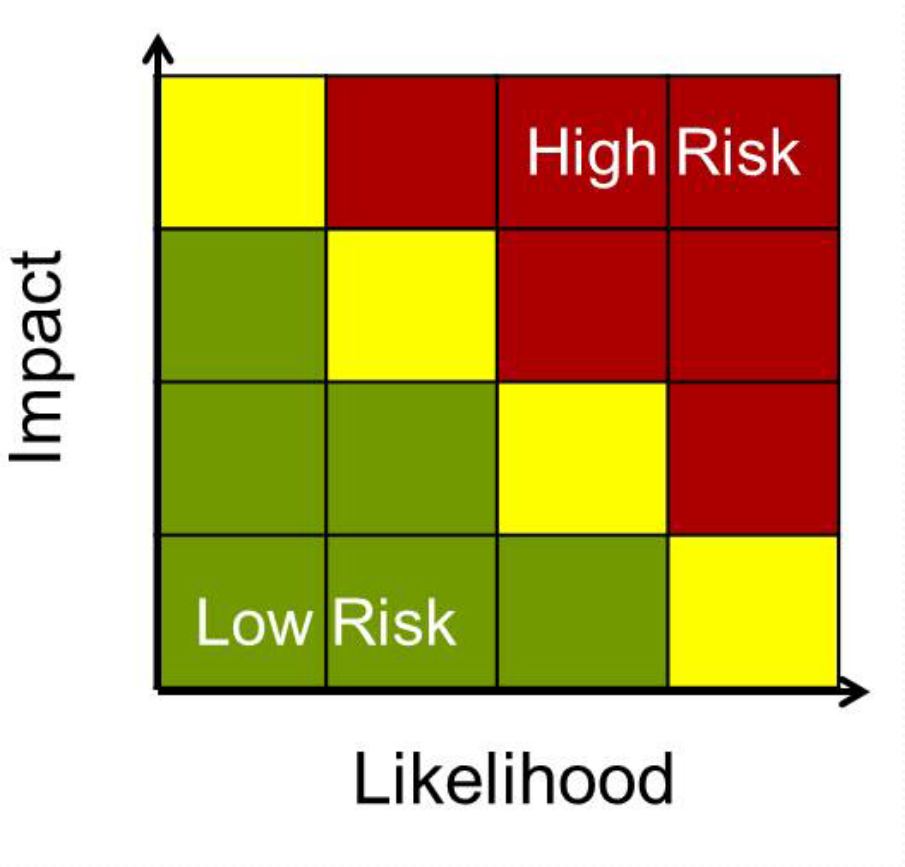
Fugitive Emissions

- Well sites
- Compressor stations
- Gas gathering / processing
- Gas conditioning

BLM – New Mexico

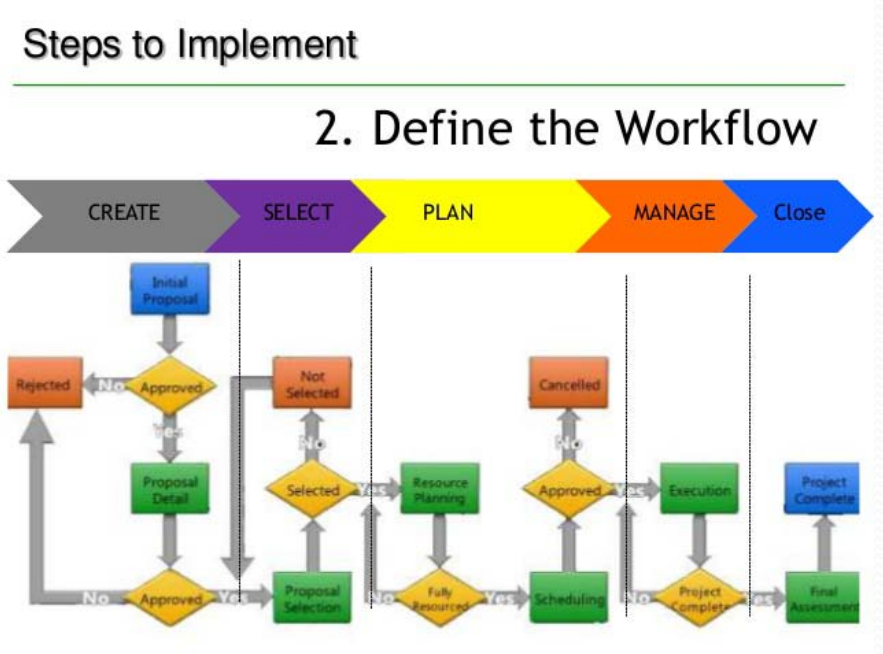
Establishing Priorities

- Risk assessments
- Financial backups
- Create heat maps for risk assessments
- Response for every possible scenario



Unique Spin on Easy-to-Understand Concept

- The concept frames the mission
- Identify who and what you are
- Nano-second “pitch”
- Map out the workflow



In single leases or units

Wellhead

Gas Gathering Systems

Compressors

Gas conditioning units

Large leases

Large mature fields

Pipelines

Developing a Monitoring Plan

- "The EPA is finalizing digital picture reporting as an alternative for well completions and manufacturer installed control devices as proposed. Specifically, the final rule allows digital picture reporting as an alternative for well completions and manufacturer installed control devices" (Federal Register, 2016, p. 35870).

Plan must include

- Can use optical gas imaging (OGI)
- OGI uses infrared detectors
- Images can be “real time”
- May use a portable volatile organic components (VOC) monitoring instrument

For New or Modified Compressors

- must conduct an initial survey
- must take place within 60 days of startup (or one year after the publication of the Methane Rule)
- monitoring must take place on a quarterly basis

Repair Leaks

- must complete within **30 days** of detection
- exception if it requires an entire shutdown. You may repair leaks during the next scheduled shutdown (or within 2 years)

Alternative Monitoring Technology

- must submit report to the EPA
- must explain how the alternative technology can detect leaks
- must demonstrate the new technology is as effective as optical gas imaging or portable monitoring instruments that detect volatile organic components

Using Drones for Periodic Monitoring and Episodic Emissions Detection in the Oil Industry

Successful deployment of drones and unmanned aerial systems for oil field monitoring depends on the correct combination of drones, sensors, and flight path / plan.

Developing the Flight Path

A few questions to ask:

- Are all the operations you are monitoring covered by the same lease?
- Same operator?
- What is the spacing? Have the gas wells been unitized?

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Developing the Flight Path

Depending on the legal situation, you may need to confine each flight path to a single lease, a single operator, or a single landowner (depending on the contracts with the surface owner).

For individual installations (individual wellheads, gas gathering systems, etc.)

Much depends on the spacing and the orientation of the gas gathering systems and compressors, etc. It may be that, due to restrictions on leases, battery time, and geography, each lease may involve a separate survey. You will need to carefully examine the structures on the surface: structures, roads, etc. in order to avoid problems.

Pipelines

Type of pipeline:

- Initial pipeline to compressors
- Gas gathering lines & systems
- Cross-country pipelines

Matching Sensors and Drones with the Realities of the Operations

- Fixed wing systems
- Multirotor systems

Whole Air Sampling Component

The air samples entered the WASC and flowed into a canister across sensors.

- Limitations: weather conditions (especially wind) affect flight stability and the accuracy of the sampling

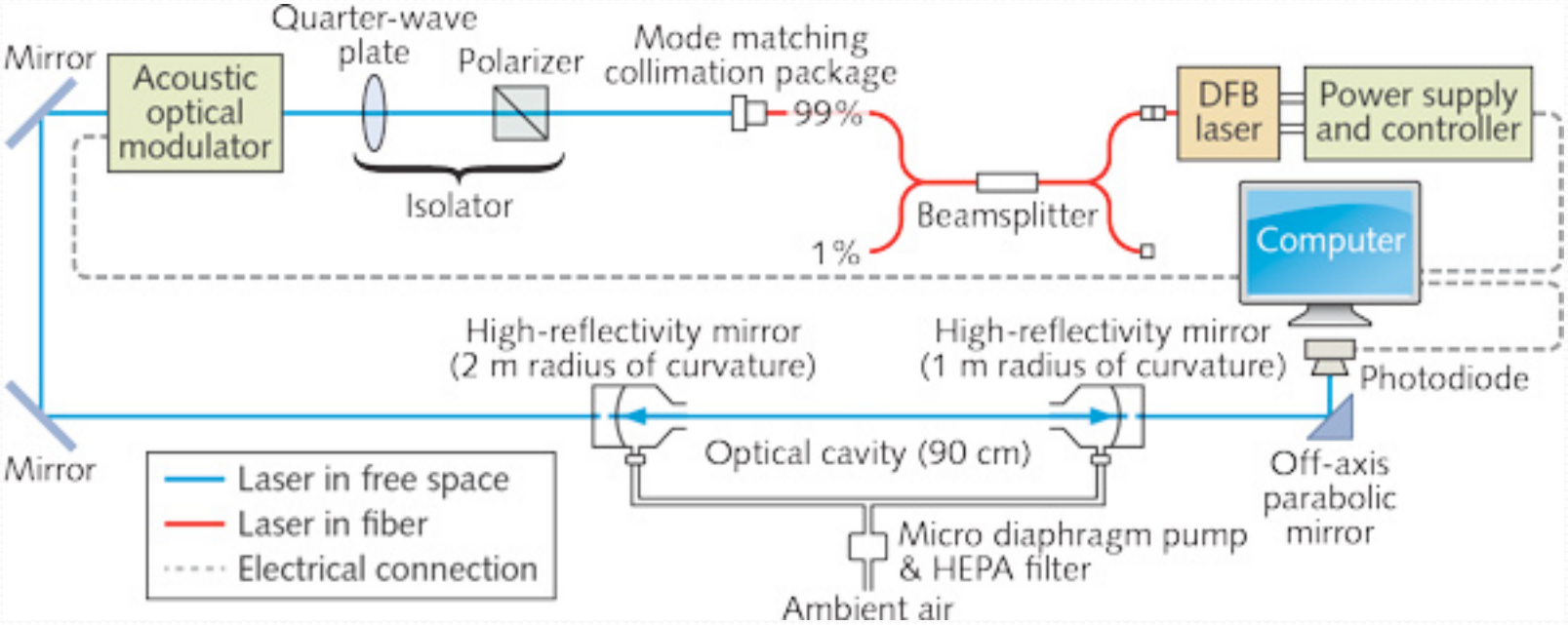
OPLS

- NASA's Jet Propulsion Laboratory's sensor: Open Path Laser Spectrometer (OPLS)
- can detect methane in parts per billion by volume
- can fit on multi-rotor drone (Vertical takeoff and landing)
- tested with propeller drone February 2016

Off-Axis ICOS

- Off-Axis Integrated Cavity Output Spectroscopy
- The battery and sensors were relatively heavy and so a fixed wing Unmanned Aerial Vehicle (UAV) was used.
- The sensors measured CO_2, H_2O and CH_4 in flights in Crow's Landing, California, and in Svalbard, Norway (Berman et al., 2012).

Cavity ring-down spectroscopy (CRDS)



Colorado State University

Hyper-Cam

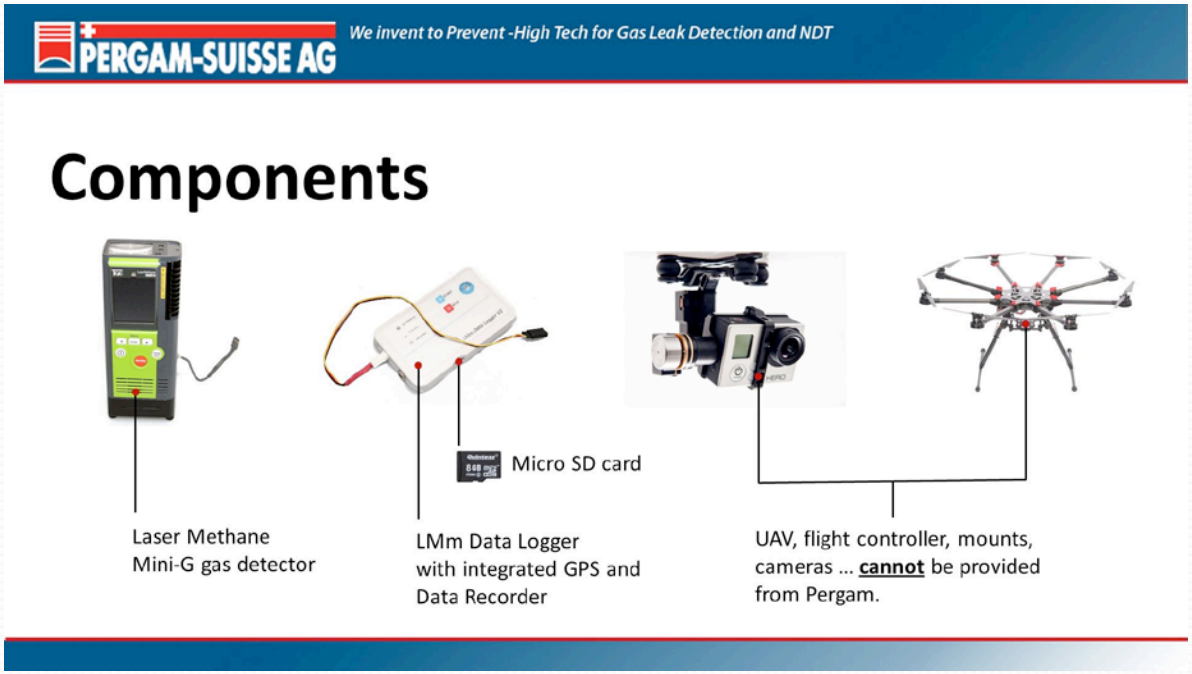
- a commercial hyperspectral imager producing high-resolution radiometrically calibrated data in real-time
- The gas signature of methane is observed when there is adequate thermal contrast (difference between the emitted gas and the background thermal background scene).

Boreal Open-Path Laser Gas Monitor

- Boreal Laser open-path laser gas monitor with an integrated transmitter/receiver unit and a passive reflector.
- The results demonstrated that a methane plume could be detected and mapped, at least in conditions of little or negligible wind.

Integrated Sensor and Data Logger

- Many companies such as Pergam manufacture a methane detector for UAVs that connects with a companion Data Logger



Integrated Sensor and Data Logger