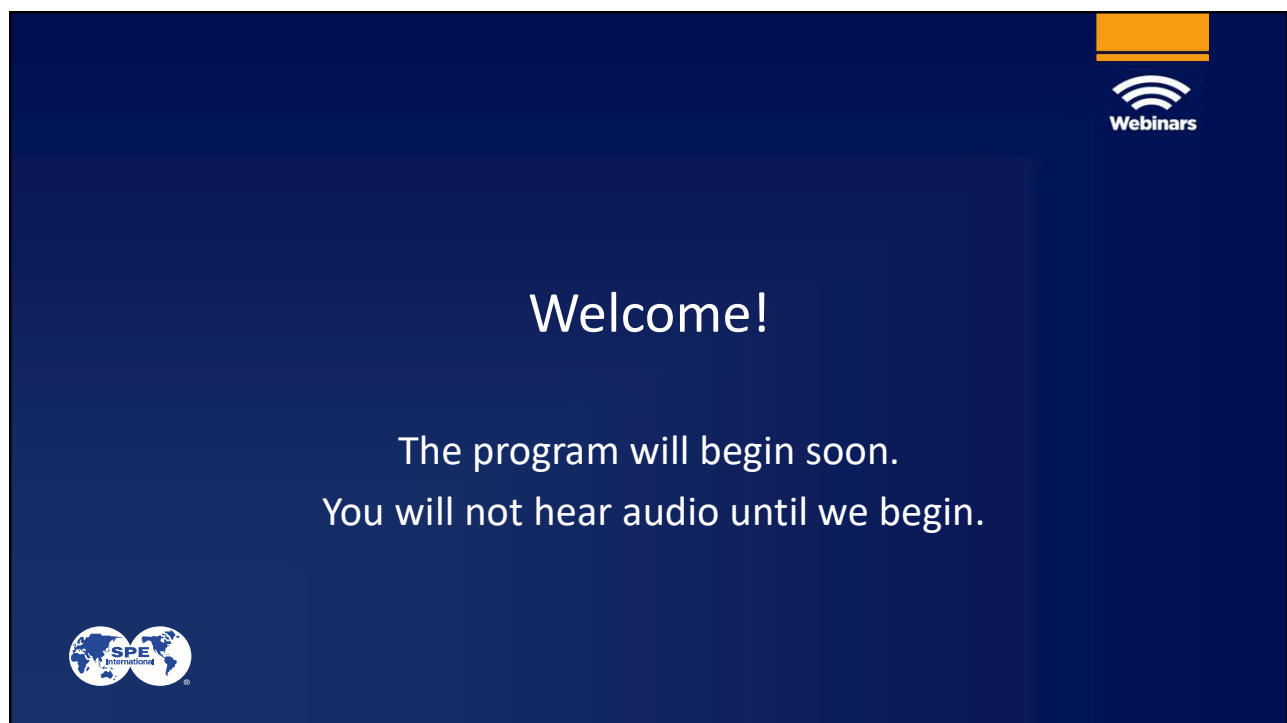




A dark blue rectangular slide with a lighter blue rectangular area in the center. In the top right corner, there is an orange square above a white Wi-Fi symbol and the word "Webinars". In the bottom left corner, there is a logo for "SPE International" featuring two globes. The central text is white and reads: "Welcome!" followed by "The program will begin soon." and "You will not hear audio until we begin."

Webinars

Welcome!

The program will begin soon.
You will not hear audio until we begin.

SPE International



**An Introduction to
Methane Emission Measurement, Mitigation
and the MEM Technical Section
for the P&F Community**







Emission Measurement

The power of reimagined multiphase flow meters

Willow Liu
October 23, 2023



Preface



- For many years, Multiphase Flow Meters (MPFM) have found application within the oil and gas industry, enabling the measurement of flow rates and the composition of fluids that encompass a blend of oil, gas, and water.
- The importance of measuring **Emission Mass Flowrates**.
- Replacing traditional separators with MPFMs has demonstrated a substantial reduction in emissions and a notable enhancement in efficiency
- To address the current shortfall of real-time emission measurement methods, MPFMs could be reimagined and expanded to measure not just the flow rates and composition of fluids but also to monitor the emissions generated throughout the entire oil and gas production, processing, and transportation processes..



UPSTREAM EMISSION ACCOUNTABILITY

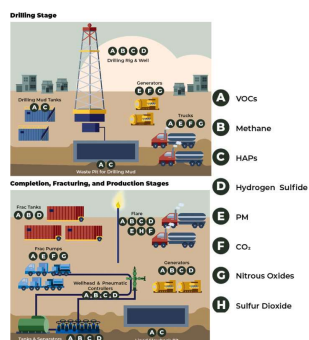
Process Emissions

tanks, fugitive and vents, valves, connections
vented emission from pneumatic devices, pumps, completion and workover

Combustion-Generated Emissions

flaring, separator/tank heaters, compressor engines, drilling & workover rigs, other engines

The optimal scenario would involve obtaining measurements directly at the primary source of all potential emissions, which is the wellhead, and subsequently accounting for any emissions that might arise downstream from this point.



MEASUREMENT CHALLENGES



Current emission measurement technologies & challenges

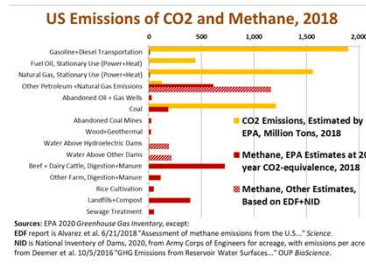
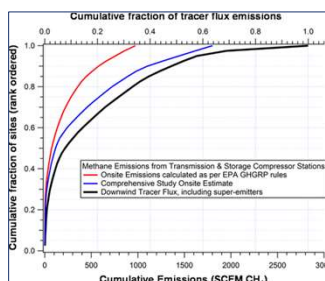
1. Direct sampling with local passive gas detection sensors (IRs, Spectroscopy, FID etc.)
 - Passive sampling (spatial variability)
 - Sample resolution
 - Humidity, wind speed/direction, ambient temperature/pressure
2. Remote/Arial sensing (aircraft, satellite, tower-mounted FLIR)
 - Spatial resolution
 - Interference
 - Weather and atmospheric conditions
3. Modeling
 - Accuracy of input data
 - Inherent uncertainties, generalized (broad) assumptions and limitation of the model
4. Non-Continuous Emission needs 24/7 Monitoring
5. Emission Concentration $\neq$ Emission Rate



REPORTING CHALLENGES

Although many countries have implemented greenhouse gas (GHG) reporting guidelines like GHGRP in Canada, significant disparities persist between government estimates, corporate self-reported data, and reports from environmental groups.

One of the primary contributing factors to these discrepancies is the absence of standardized measurement methodologies and data standards.





Multiphase Flow Measurement Opportunities and Advantages



Emission Measurement – The Power of Reimagined MPFM

9

MPFM @WELLHEAD



- MPFM is compact, and can be installed directly at the wellhead, the production source downstream of which potential emissions will occur.
- MPFM provides continuous volumetric and mass flow rates measurement.
- Recent years of MPFM technological advancement has enabled lower cost MPFM to be permanently installed on each well head.
- By simplifying and streamlining processes, the use of MPFM in well test operations can lead to a significant reduction in potential emissions.



10

MPFM REALTIME OUTPUT

1. MPFM provides real-time production volumes and mass of gas prior to separation.
2. The MPFM data output provides a benchmark upon which total emissions can be derived (MPFM minus Production).
3. The accuracy and scalability of MPFM data visualization over extended time frames can be improved through the use of machine learning.

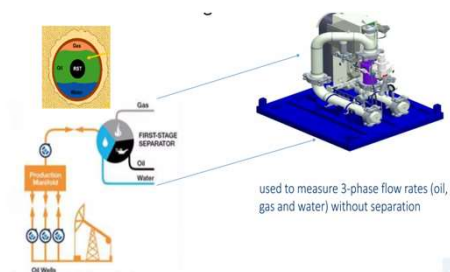


11

MPFM DATA ADDS ACCOUNTABILITY



The accountability of emissions is helped by the use of MPFM in many ways:



- The measurement of total surface production is performed at the source with minimal emissions at the wellhead.
- The total amount of gas is measured, both **in volume and in mass**; the data is essential to identifying the potential emissions loss downstream of the wellhead.
- MPFM minimizes upstream process emission by eliminating valves, connections and pneumatic devices for separation.



12

MPFM +



1. MPFM + additional sensors – detect and quantify methane, CO₂ and VOCs real-time.
2. MPFM + IR cameras and drones – wide area emission assessment from various sources, flaring, venting and fugitive leaks.
3. MPFM + Virtue FMs at each wellhead to create a comprehensive, efficient but cost effective (and low maintenance) measurement package to quantify both production and emissions.
4. MPFM + Machine Learning and AI algorithms – By learning from the past, it is possible to gain insight into the future and take action to minimize emissions.



13

MULTIPHASE FLOW MEASUREMENT/METERS



- Mature technology. Realtime, continuous measurement. SCADA and audit ready for reporting integrity. Combines with other digital technologies, and integrates with process automation and optimization, enables faster response and decision-making in emission management.
- Measurement of total gas at the source, providing benchmark for potential upstream emission.
- Volumetric and Mass measurement, not affected by changes in atmospheric conditions, especially humidity (wet gas model);
- Combine multiple MPFM units, passive gas detection sensors, AI algorithm can achieve superior accuracy, spatial resolution;
- By replacing conventional separator and single phase flow meters, cut emission from the source and eliminating valves, pneumatic devices and connections.



MPFM TECHNOLOGIES

STILL HAVE A LONG WAY TO GO

- The cost and expertise to apply the technology at every production source can be prohibitive.
- The implementation and logistic of emissions capture within the upstream production processes is lagging measurement capabilities.
- Production measurement and capture of emissions should go hand-in-hand.



15

SUMMARY



- Measuring at the original source of potential emissions is the cornerstone of accountability.
- What is measured eventually improves.
- MPFM reduces potential emission, reduces OPEX, improve digitization and visibility of emission measurement.
- MPFM is an important addition to the current measurement technologies.
- MPFM can lead the next generation technology innovation in emission measurement.



16



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17



Methane Emissions Reduction: Enabled through Automation and Measurement

Brendan Smith
Co-Founder & CTO, SeekOps Inc.
Program Chair, SPE USYS Technical Section
23 October 2023

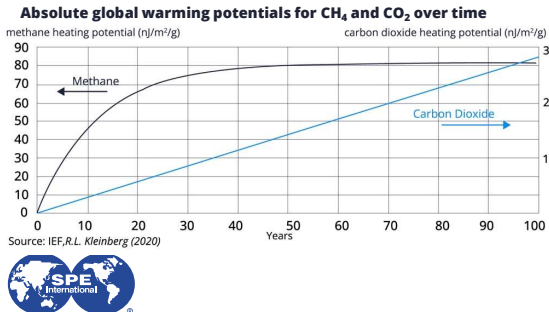


The seven hottest years on record were the last seven



Methane is responsible for 30% of the current global temperature rise

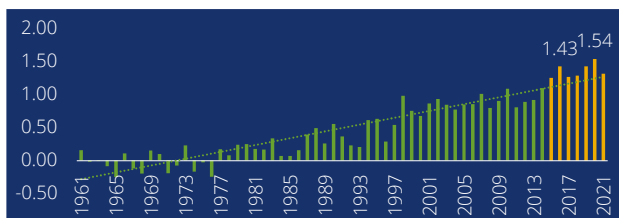
- Methane is **84x more potent** at trapping heat in the earth's atmosphere on a 20-year timeframe.
- Methane **impacts how quickly** temps rise.



Global CO₂ emissions reached their highest level ever in 2021

- CO₂ emissions from energy combustion and industrial processes **increased by 6%** in 2021.
- CO₂ **impacts how much** temperatures rise.

2015 – 2021 were the hottest years since 1961



Source: <https://climatechangedata.imf.org>

Driver: Methane Emissions Reduction



- Oil & Gas operators committed to **Net Zero**
- **OGMP 2.0**
 - UNEP Initiative
 - Gold Standard: Accurate Measurement and Reporting
- **COP26 Methane Pledge**
 - Reduce Methane emissions from all sources by **30%**
- **OGCI "Aiming for Zero Methane Emissions" Initiative**
 - Net Zero by 2030 with transparent reporting of emissions, transitioning to measurement technologies
- Emissions reporting frameworks turning focus to **measurement and verification (top-down)** in addition to estimation (**bottom-up**) to reach emissions reduction



355Mt

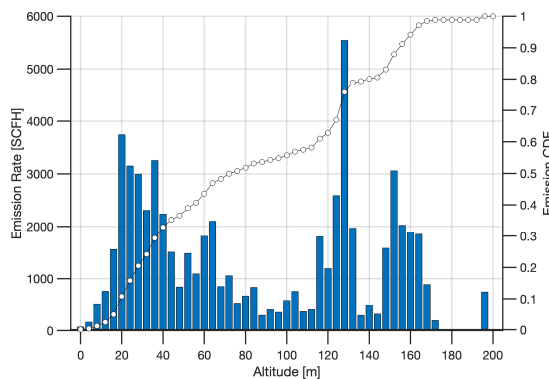
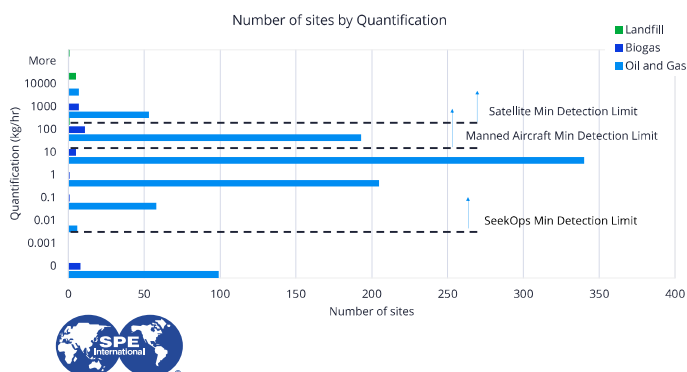
2022 Global Methane Emissions

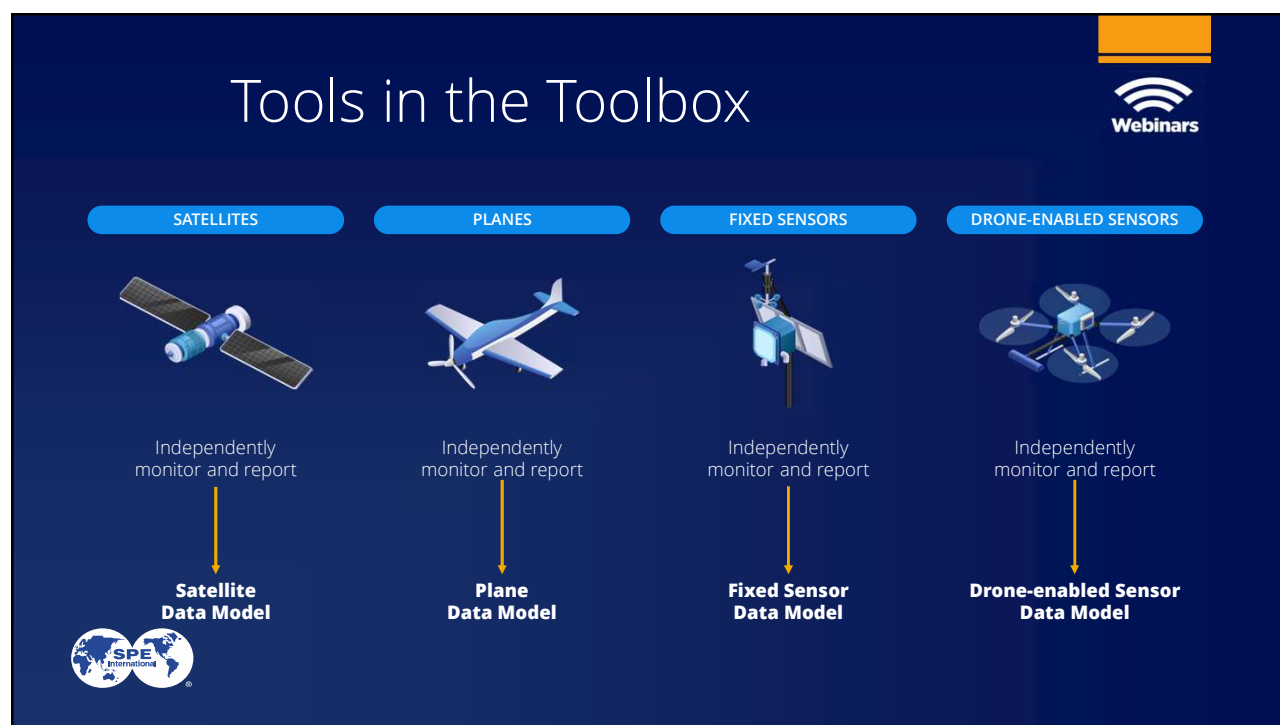
From
IEA

Complexity of the problem



Sites that fall below the detection threshold of aircraft and satellites make up more than 50% of methane emissions in the US (Ref: EDF)





Together, we can act *faster* to reduce global emissions

-  **Satellites** and **continuous sensors** pull low resolution data frequently and trigger detailed site surveys.
-  High resolution **drone-deployed sensors** directly measure 100% of methane emissions and create detailed heatmaps.
-  **LDAR** uses **combined data** to pinpoint leaks on-site.
-  OGMP & ESG Records updated on **common software platform**.



Methane Emissions Markets

Conventional Oil & Gas

Onshore & Offshore
Midstream
Plug & Abandonment



Renewable Natural Gas

Biogas/Biomethane



Waste Management

Wastewater
Landfill Gas



Utilities

Compressors/Pipeline
Gas Storage (LNG)
Metering & Regulation



- Leak Detection & Quantification
- Asset Level for ESG Reporting
- Responsibly Sourced / Certified Gas (MiQ, EO, etc)
- Carbon Credits – particularly biogas/landfill RNG

Automation: Onshore Oil & Gas Operations



Survey Execution and Repeatability

Flights are extremely repeatable. Multiple survey flight paths were able to be completed within centimeters of each other:



Automation Workflow Example



Pad	Survey Group	Emissions Found / OGI Follow-up	Component Source 1	Component Source 2	Component Source 3	OGI Video File Name
1	Wellhead	No				
	Separators	Yes	Level controller	Manifold Flange		
	Tanks	Yes	Thief Hatch N	Thief Hatch S		
	Pig Launchers	Yes	Barrel Door			
2	Wellhead	Yes	Chem Pump			
	Separators	Yes	Regulator Packing			
3	Tanks	No				
	Wellhead	No				
4	Wellhead	Yes	Regulator Packing			
	Separators	Yes				
5	Tanks	No				
	Wellhead	Yes	Valve Packing			
	Separators	Yes	Compression Fitting	Flange		
6	Tanks	No				
	Wellhead	Yes	Threaded Connection			
	Separators	Yes	PRV	Level Controller 1	Level Controller 2	
	Tanks	No				



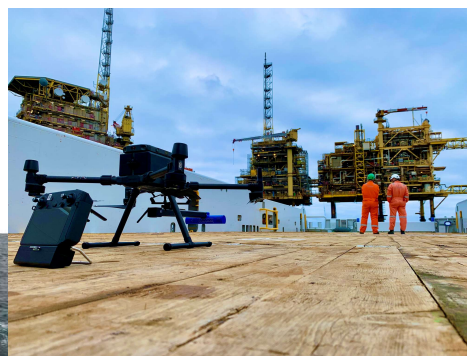
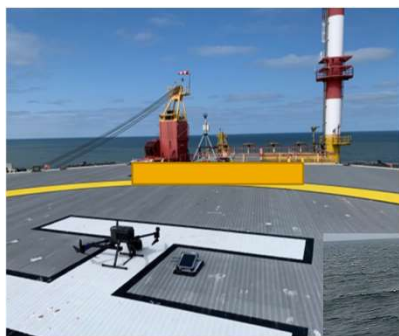
FLIR

Work Order for Repair





Drones: Onshore & Offshore Deployment

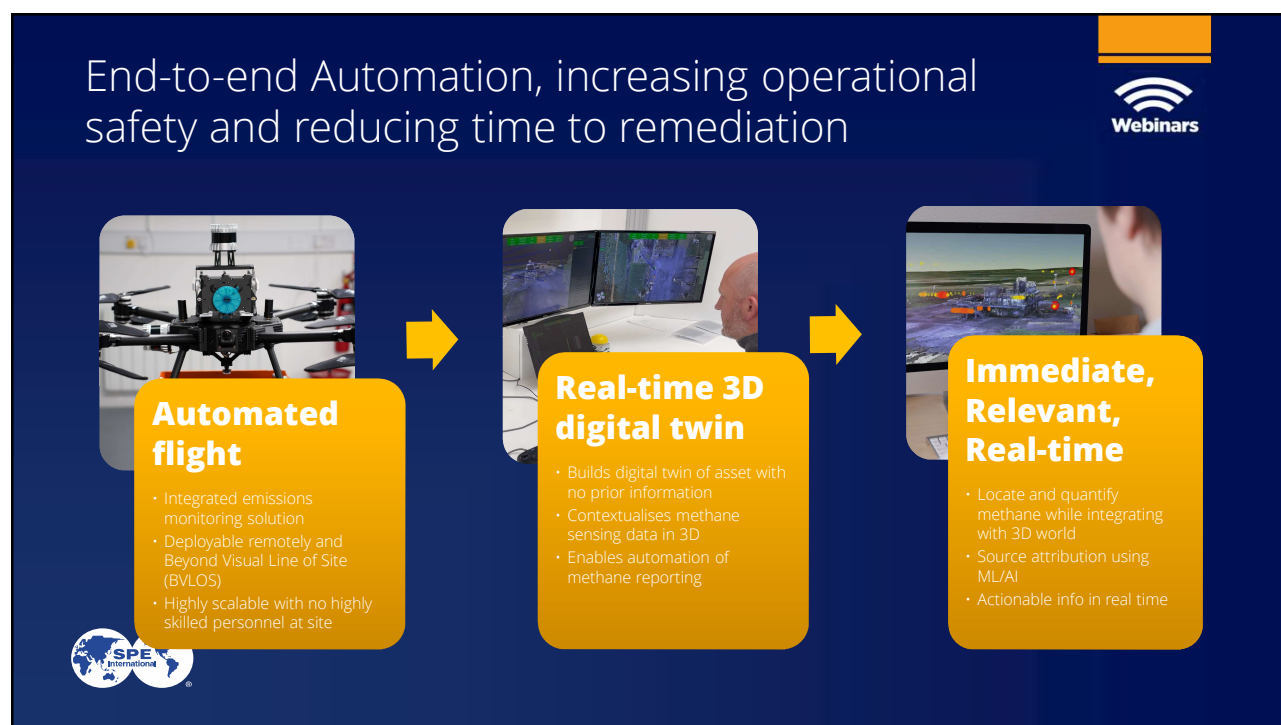


Where do I see the future?



- Expansion beyond Imagery Surveillance and Mapping
 - Sensor suites for precision measurements
 - NDT
 - Manipulation – interfacing with other objects
- Multimodal Sensing
 - A variety of robotics and stationary sensors – leveraging IIOT for communication that is bi-directional
- Dynamic re-tasking
- A lot of cross-pollination from surface or sub-sea robotics





Bottlenecks



- Regulation
 - BVLOS – currently driven by drone delivery & surveillance
- Technology (far less than we think)
 - Battery / Power source
 - Have experienced a 4x increase in endurance over 5 years from battery optimization
 - Alternative sources – hydrogen, petrol, etc.
 - New battery or power storage technologies
 - Obstacle Avoidance
 - Not ubiquitous across all drone platforms. A couple key players doing it “right”
- Standardization
 - Both Uncrewed Systems related and Inspection protocol



Thank You!



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