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Methane Emissions Detection and Quantification Technologies and New Approaches to Emission Reductions

Jim Crompton and Nick Pinto

September 22, 2022

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EDF Environmental Defense Fund — Finding the ways that work

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Finding the ways that work

Measure What Matters

SPE Methane Emissions, IOGCC, & EDF
September 22, 2022
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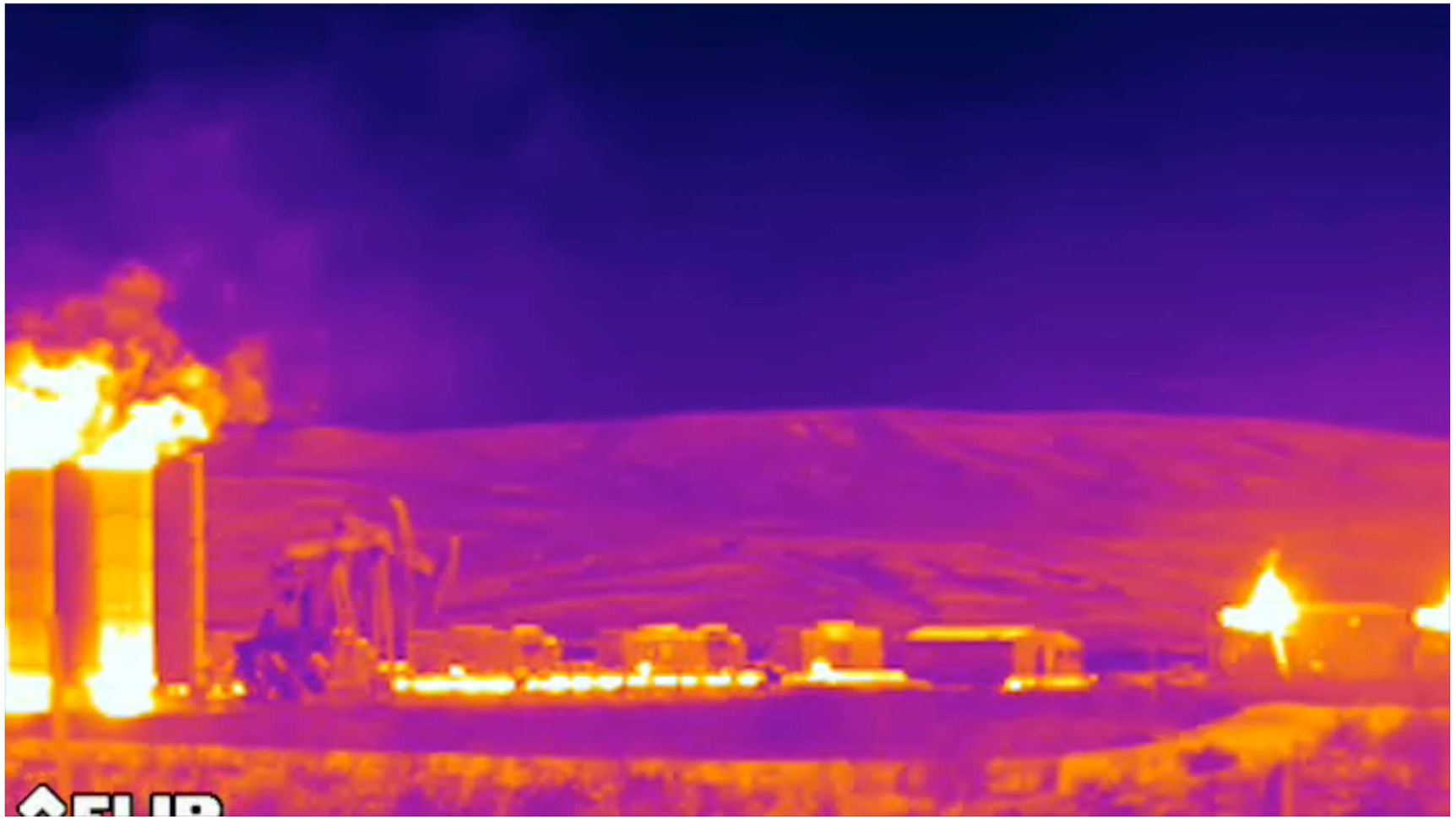


Infrared video, taken from the FLIR GF320 camera, shows the emissions from the stacks at the D90 natural gas production site July 26 in Jackson County along Colorado 14 outside Walden. Not visible to the naked eye, the infrared version captures the evidence of heat with plumes of hydrocarbon emissions being carried away off site. (Andrew Klooster, Special to The Colorado Sun)

Measurement Matters

- We have become used to compliance with existing environmental regulations where estimates and emissions factors, rather than measurements, were the rule and actions were driven by permits and fines rather than based on the data available.
- That world is changing. More data is now available and much more is coming. New realities are enabled by data-driven predictive models that are limited by uncertainties, biased data sets and assumptions. The integration of different time scales, intermittent events and measurements from satellites down to ground sensors are today's challenge.

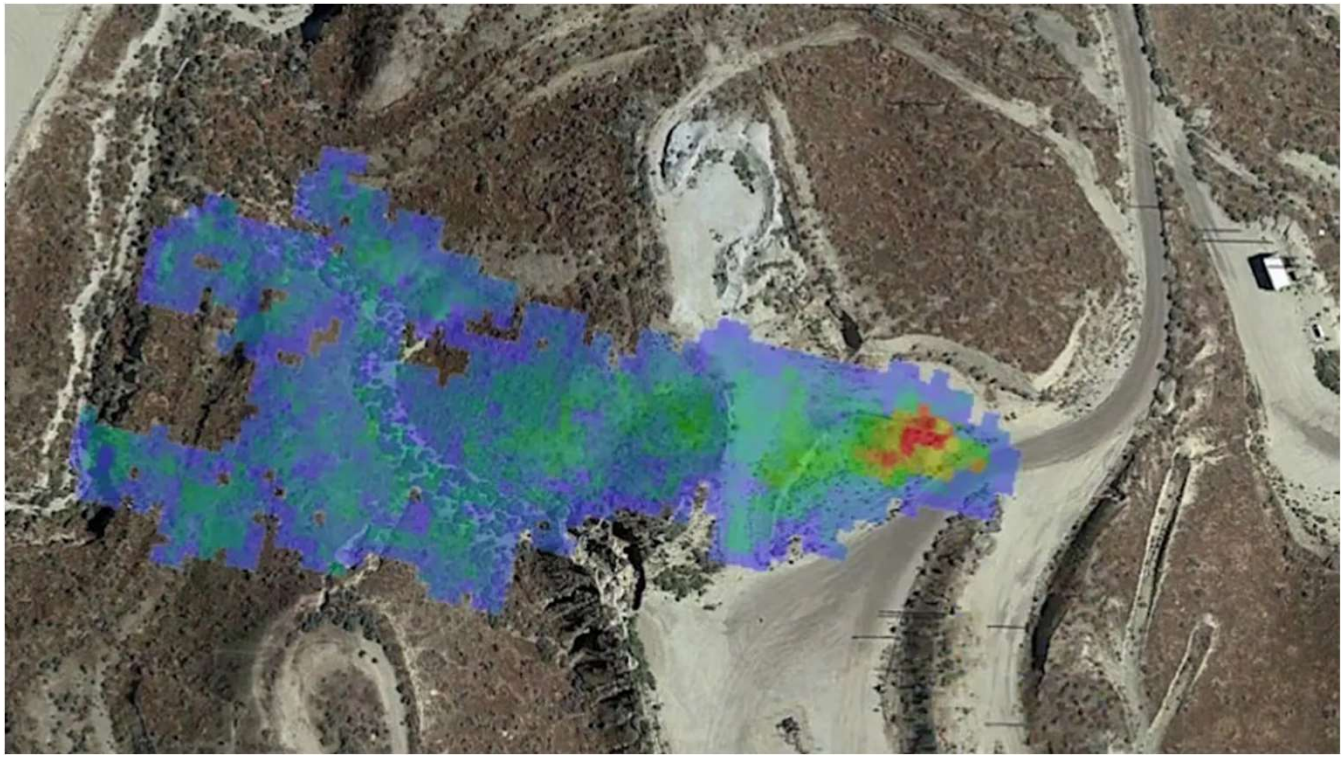
Measurement Matters, Not Estimates

- An **emissions factor** is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category.

- The general equation for emissions estimation is: $E = A \times EF \times (1-ER/100)$
  - where:
    - E = emissions;
    - A = activity rate;
    - EF = emission factor, and
    - ER =overall emission reduction efficiency, %

How You Measure Matters

There is Nowhere to Hide



What Kind of Measurement Matters

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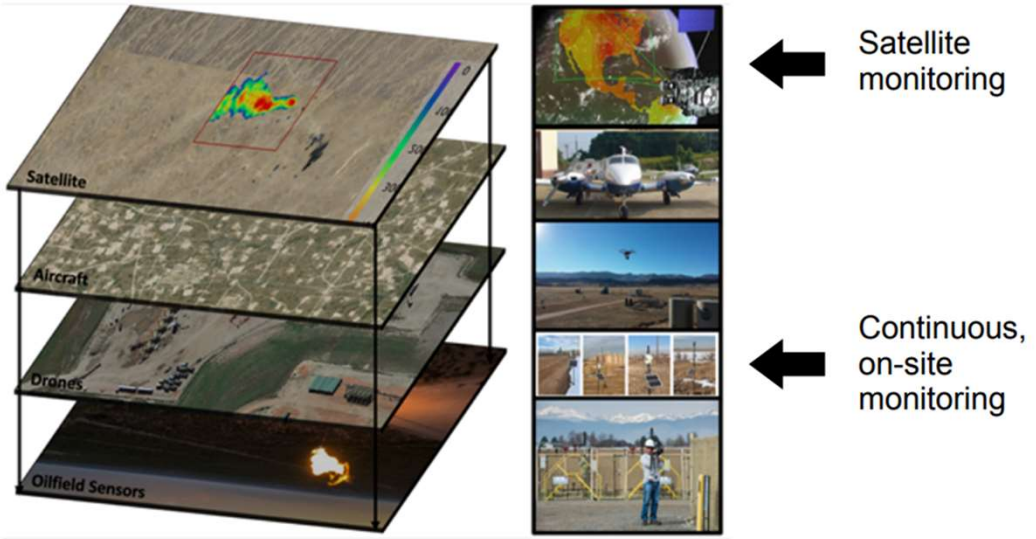
Digital Canopy



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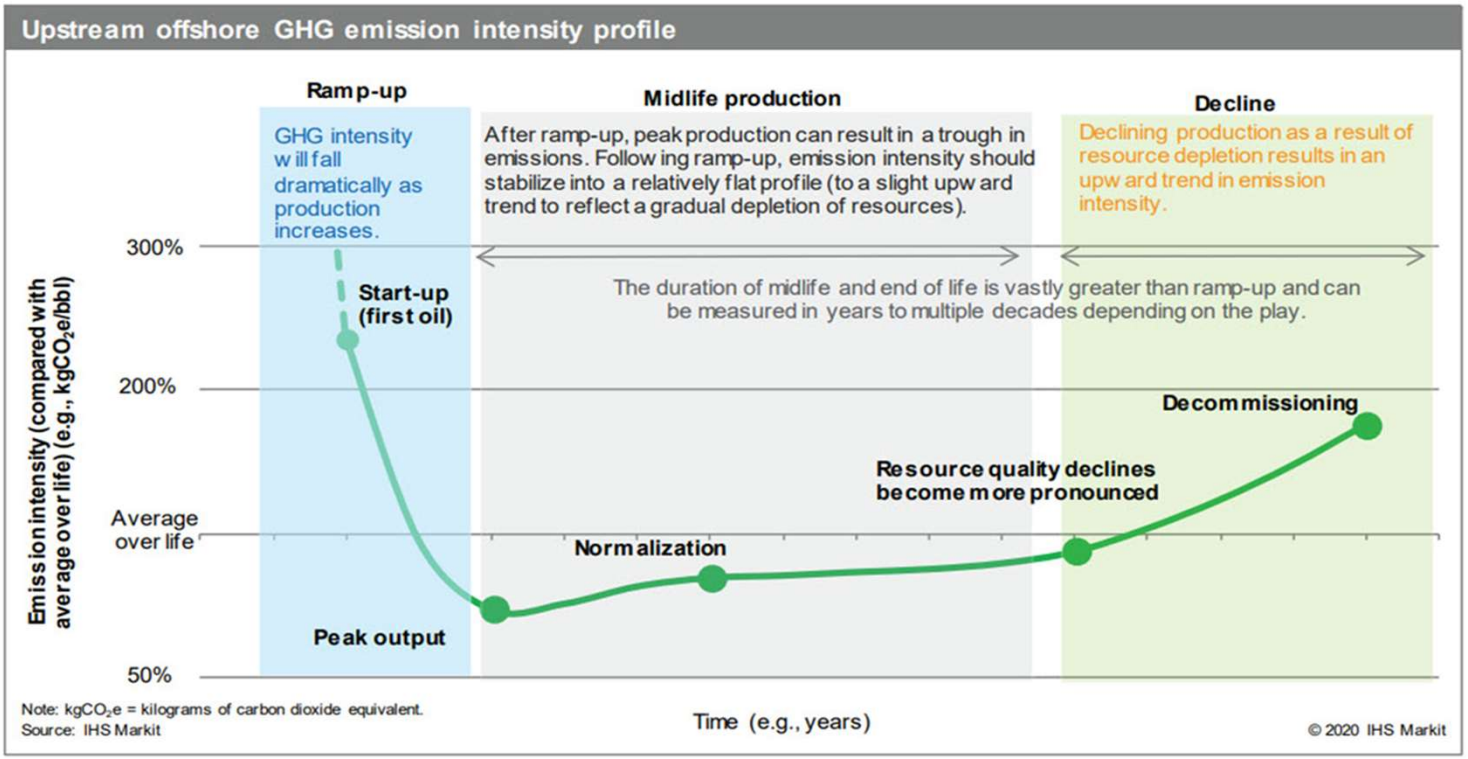
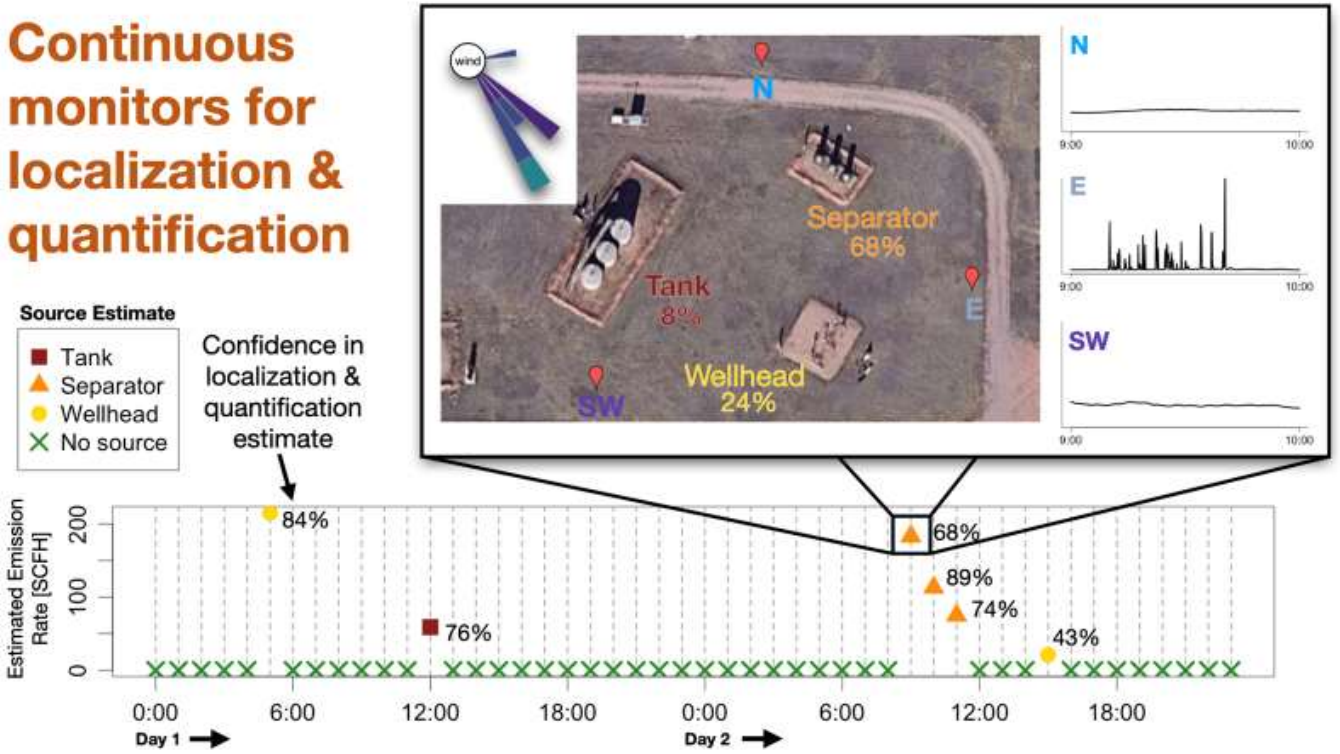
When Your Measurement Matters

Figure 2



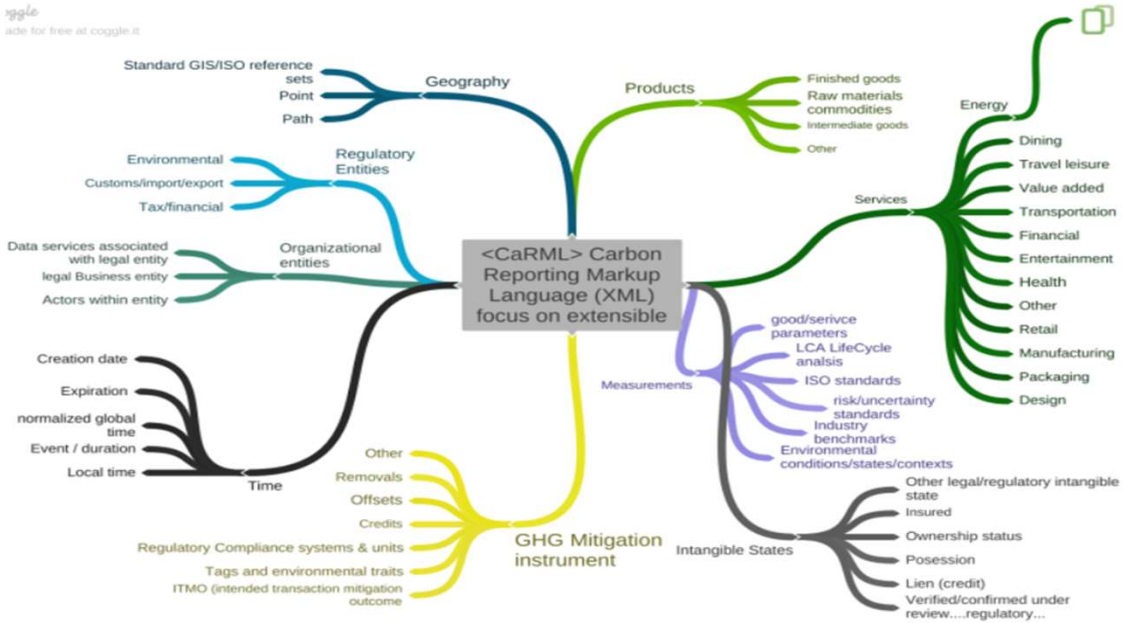
Verification Matters: METEC Facility in Fort Collins, CO

How You Display Measurements Matters



How You Report Matters

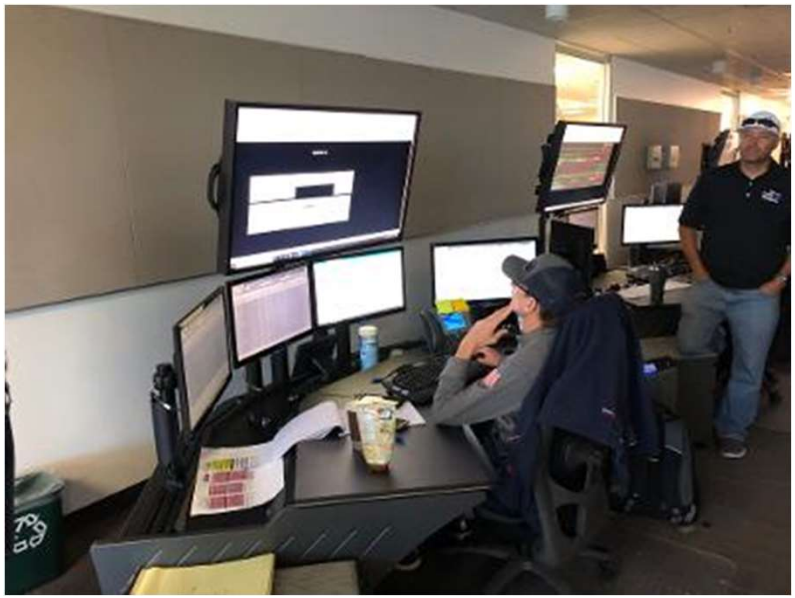
Schema



Design Emissions Out

- Tankless (pipelines for crude oil, natural gas and produced water)
- Electrification (from grid if possible)
- Pneumatic Valves using Instrument Air

Design Emissions Out



- Comprehensive Development Plan and predictable permitting process
- Process Control and Automation
- Community Engagement
- Measurement and Reporting

Measure What Matters

- It matters **what** you measure
- It matters **how** you measure
- It matters **when** you measure
- It matters how you **verify** your measurements
- It matters how you **report** your measurement
- It matters how you **use** the data (more responsive LDAR)
- But ultimately, measurement is not the end goal. You need to use the data to understand how your facilities operate and **design emissions out**.

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Methane Emissions Measurement and Quantification Technologies

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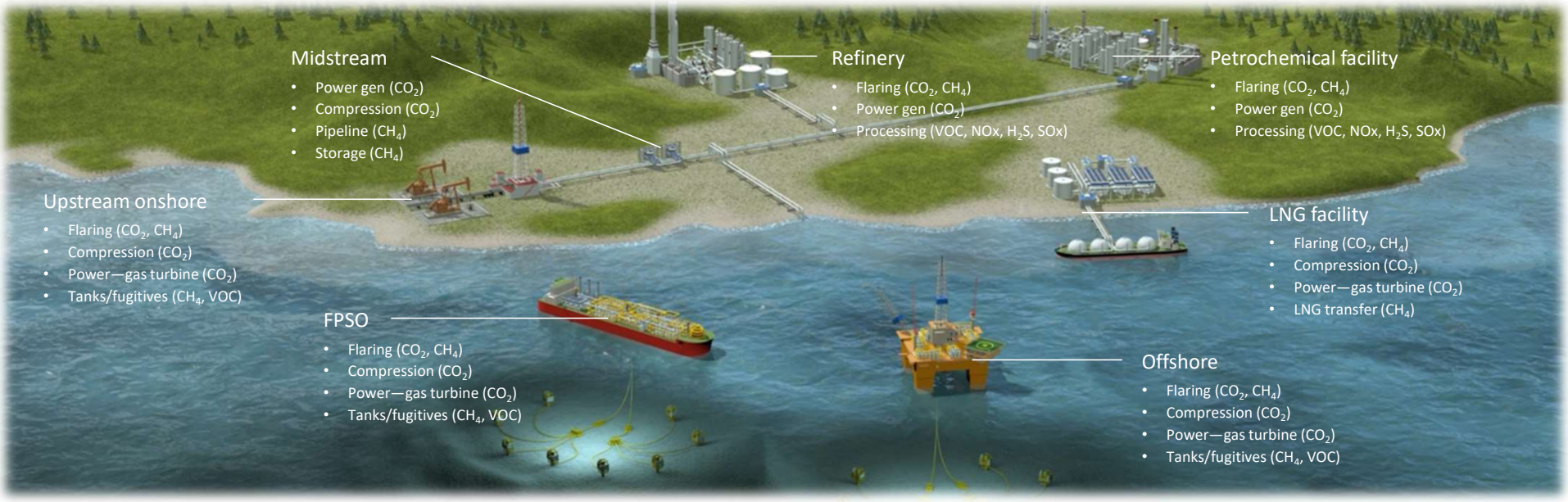
Topics For Discussion

- Methane as a Greenhouse Gas
- External Pressures on Operators to Measure Their Methane Emissions
- Summary of Conventional Methodologies for Methane Emission Measurement
- Summary of Advancements in Methane Emission Measurement Technology

Methane as a Greenhouse Gas



- Methane is the 2nd largest source of greenhouse gas after Carbon Dioxide
- CH4 is 25x more potent than CO2 and 84-87x more harmful to the environment over a 20-year period
- Incomplete combustion, tank venting, and loss of containment represent the most common sources of methane emissions and can be found amongst all processes within the Oil & Gas industry

External Pressures for Methane Emissions Management

Regulatory

Rapidly evolving with new timelines and plans across various countries, heading towards fully regulated market where emissions are measured/quantified—not just estimated.

USA: Federal, State, and Municipal

Financial

Sustainability is high on the regulators & investor's agenda to stimulate investment in mitigation/low-carbon options and keep cost of capital low, with mounting public pressure to reduce emissions with carbon prices driving actions by energy-intensive industries and expanding agenda of sustainable finance.

ESG

Environmental, social, and governance (ESG) concerns are increasingly prominent. Responsible sourcing is the new standard and customers must demonstrate material emissions reductions to maintain social licenses to operate.

Source-level and site-level measurement of emissions, and subsequent ability to reconcile, becoming a common element amongst regulations and standards

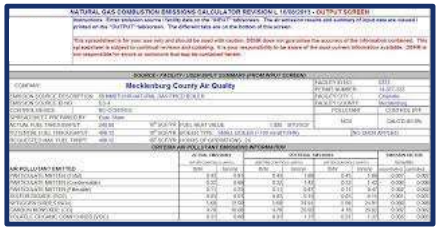
Conventional Methods for Methane Emission Measurement & Detection

Handheld OGI Camera

- OGI: Optical Gas Imaging
  - Infrared Spectroscopy
- Personnel-intensive
- Limited to clear line-of-sight and ability to safely maintain proximity
- Most often provides a ppm concentration output
- Flow-rate or volume quantification requires additional costly analytics

Extractive Sampling

- Requires collecting samples, whether via probe in-line to a specific process or an atmospheric “sample bag” collection.
- These samples are then measured in costly analyzers to determine gas composition.
- ppm concentration or mole% needs to then be compared to process data to determine flow-rate or volume quantification

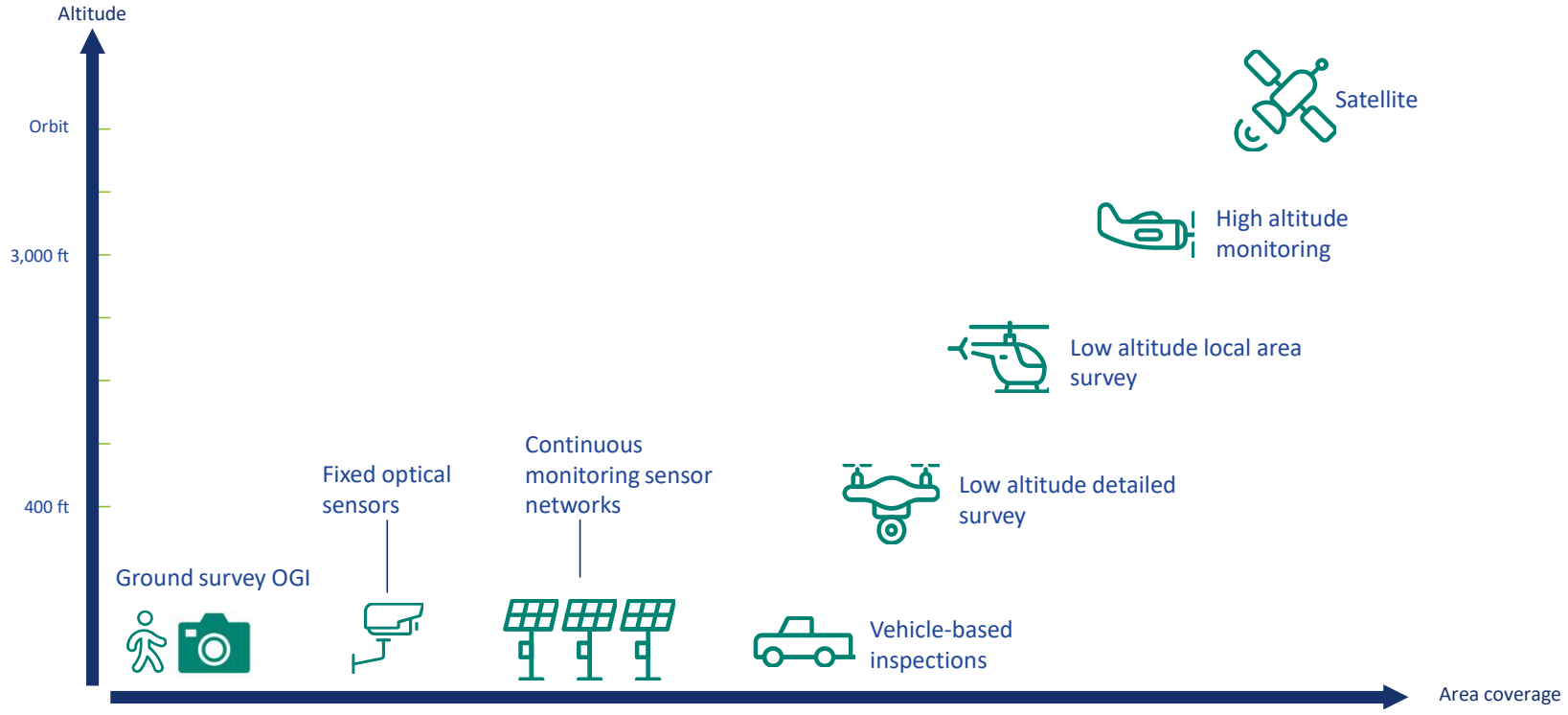


Emissions Factors

- Utilizes predetermined factors associated with specific processes and equipment to determine estimated emissions based on process data
- History of proven inaccuracies
- Majority of new regulations and additional external pressures focus on the requirement of measurement vs. estimation

Methods above are intended for source-level measurement

Advancements in Methane Emission Measurement & Detection



There are many sensing technologies and inspection methodologies available to operators today. Each providing unique advantages and additional data to assist with the overall reduction of methane emissions.

Deeper Look into Technology Advancements

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Handheld OGI w/ Quantification

- Uses OGI, Optical Gas Imaging, technology
- Cooled Infrared camera designed for absorption spectroscopy of hydrocarbon ppm using background radiation
- Requires additional computer vision analytics for quantification.

- **<1kg/hr quant w/ analytics**
- **Source-level only**
- **Req Boots on the ground**

Ground-Based Continuous Monitoring

- Sensor network utilizing MOS, NDIR, PID, or MEMS technology to measure CH4 ppm
- Combines with GPS location and wind speed/direction data
- Creates physics-based modeling for gas plume and quantification.
- Allows for easy correlation of emissions data and site process data

- **<2kg/hr quant w/ analytics**
- **Source & Site level capable**
- **Continuous, near-real-time**

Detailed Survey UAV Inspections

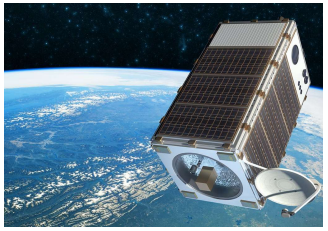
- Drone outfitted with RGB, OGI, LiDar, or TDLAS sensor technology.
- Pinpoint localization precision available.
- Additional AI and computer vision analytics provide plume model quantification and component recognition
- Increased efficiency and cost-effectiveness allows for more frequent inspections

- **<1kg/hr quant w/ analytics**
- **Source & Site level capable**
- **Wide-spread adoption of UAV in process**

High Altitude, Manned Local Area Survey

- Plane/Helicopter outfitted with LiDar or TDLAS sensor technology.
- Used for large area coverage of densely populated assets
- Most often used for heat-map generation, of site level emissions and major emitters.
- Mainly PPM, limited quantification capabilities

- **>10kg/hr quant w/ analytics**
- **Site-level only**
- **Costly for larger/fewer sites**



Satellite Tasking for Methane Emissions

- Satellites outfitted with LiDar or additional IR spectroscopy sensors
- Utilize both public and private satellite data
- Identification/Quantification of more super-emitters
- Ability to either quantify via leak rate or volume or localize to individual sites only available with potentially cost-prohibitive solutions.

- **>100kg/hr quant w/ analytics**
- **Site-level only**
- **Costly tasking and data**

Advancements in Methane Emission Measurement & Detection Continued

Newer methodologies such as UAV solutions and continuous monitoring sensor networks provide for cost-effective measurement and quantification of methane emissions, at both source-level and site-level.

Method	Quantification	Source-Level	Site-Level	Inspection Frequency	Cost
Satellite	Mainly Concentration	✗	✓	On-demand	$$$$$
Manned Fixed-Wing	Mainly Concentration	✗	✓	Quarterly to bi-annual	$$$$
Manned Helicopter	Concentration, limited leak-rate analytics	✓	✓	Quarterly to bi-annual	$$$$
UAV	Physics-based leak-rate and concentration	✓	✓	Quarterly to bi-annual	$$
Ground Vehicle Inspection	Concentration, limited leak-rate analytics	✓	✗	Monthly to quarterly	$$
Continuous Monitoring	Physics-based leak-rate and concentration	✓	✓	Continuous	$$
Fixed Optical Sensors	Concentration, limited leak-rate analytics	✓	✗	Continuous	$$$
Handheld OGI Inspection	Concentration, limited leak-rate analytics	✓	✗	Daily to quarterly	$$$$

Source-Level vs Site-Level Measurement

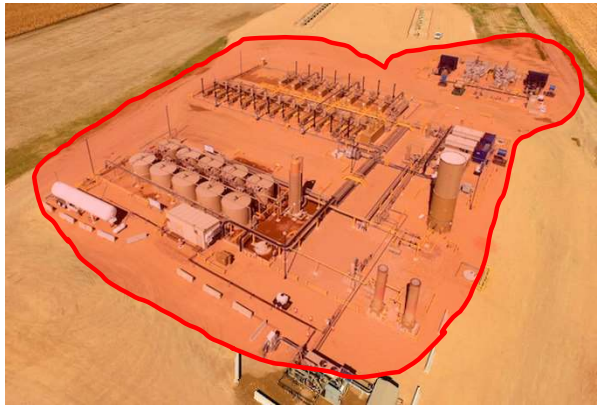
Inventory of Emission Sources

- P&ID, Tag Lists, Previous LDAR, etc.
- Prior Emission Factor Calculations.

Source-Level Measurement

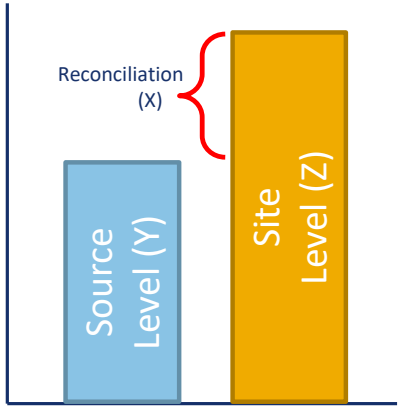
- Source-level measurements focus on specific components or pieces of equipment (i.e. thief hatch above)

Site-Level Measurement



- Site-level measurements typically conducted on a less frequent basis
- Designed to encompass all emissions sources on site and quantified on a per-site metric.

Reconciliation of Source vs. Site



- Solve for "X"
- Understand source level emissions not previously accounted for
- Understand intermittent vs persistent emissions

Emission measurements based on leak-rate or volume are paramount for effective monitoring, reporting, reconciliation, and prioritization or repair and abatement resources.

Questions?

THANK YOU