July 2021

Real-time monitoring of methane emissions

Stanford NGI
October 20, 2021

PROJECT CANARY

Project Canary provides trusted & independent ESG data across the energy supply chain.

Project Canary

Certified B Corporation

Project Canary is a public benefit corporation that acts as an environmental credit rating to help operators reduce emissions to net zero.

Products

TrustWell gas certification

Continuous monitoring

The TrustWell by Project Canary certification program evaluates engineering & operational performance for the energy sector. The Project Canary real-time, continuous emissions monitoring platform is used by ESG-minded, emission intensive industries.

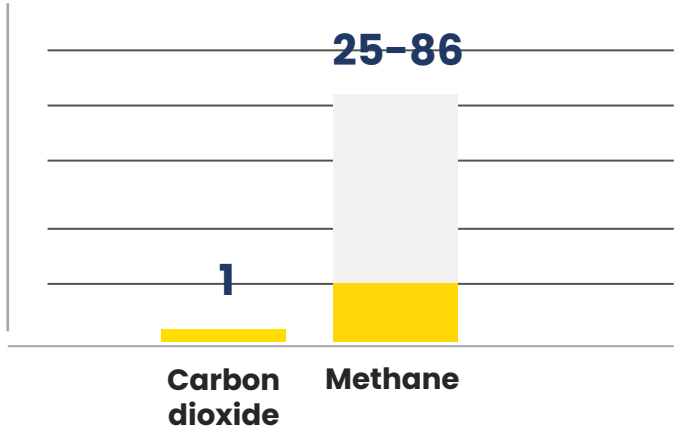
Project Canary by the numbers

- **Contracts** with 44 companies
- **TrustWell Certifications** – 10,000+ by year end 2021
- **Continuous Monitoring** – 722 current, 1,000+ installed by year end 2021
- 48 employees, expected ~70 FTEs by end of year
- Contracts with operators in all major producing basins, including: Marcellus, Utica, Haynesville, Cotton Valley, Scoop/Stack, Barnett, Eagle Ford, Permian (TX & NM), Uinta, DJ Basin, Green River, Powder River, Bakken

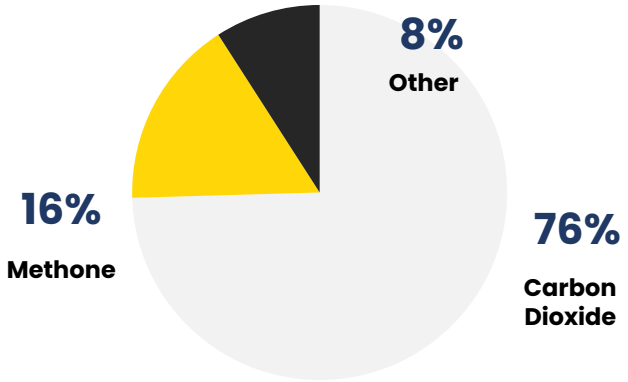
Project Canary monitors live in the field as of October 2021

The impact of methane on climate is significant: 25-86 times worse than carbon dioxide

Global Warming Potential



Contribution to Climate Change



Reducing methane is the fastest strategy to slow global warming:
2021 UN Global Methane Assessment Report

POLITICS

The world needs to dramatically cut methane emissions to avoid worst of climate change, UN says

PUBLISHED THU, MAY 6 2021-11:30 AM EDT
UPDATED THU, MAY 6 2021-12:32 PM EDT

Emma Newburger
@EMMA_NEWBURGER

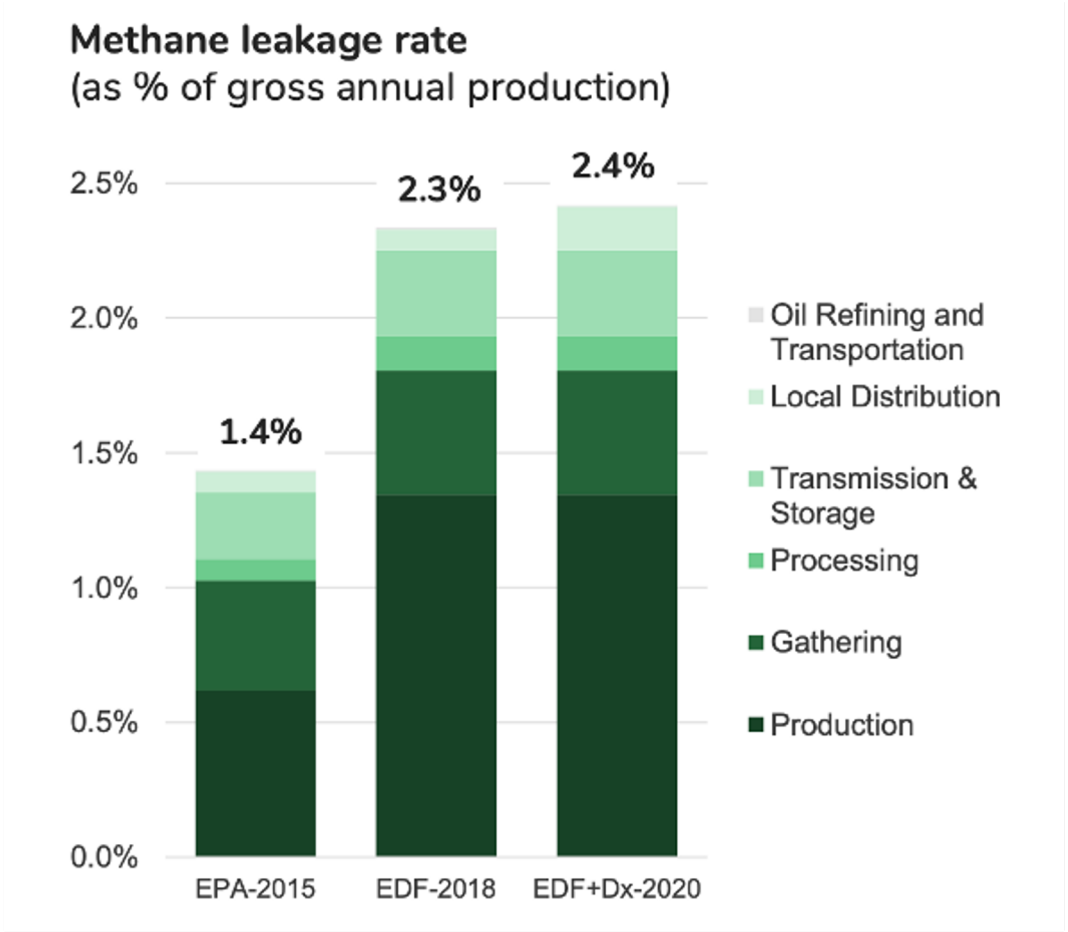
The New York Times

Climate and Environment › | The Bootleg Fire | Public Lands Overseer | Wildfire Tracker | F.A.Q.

Halting the Vast Release of Methane Is Critical for Climate, U.N. Says

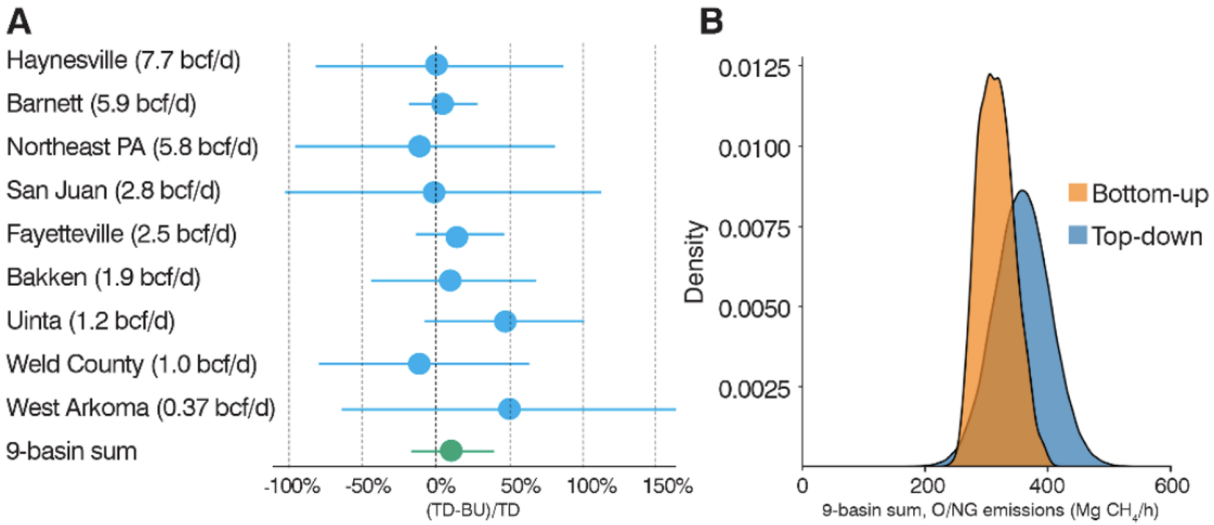
Source: 2014 IPCC (Intercontinental Panel on Climate Change) Report. 1) other includes Nitrous oxides and fluorinated gases.

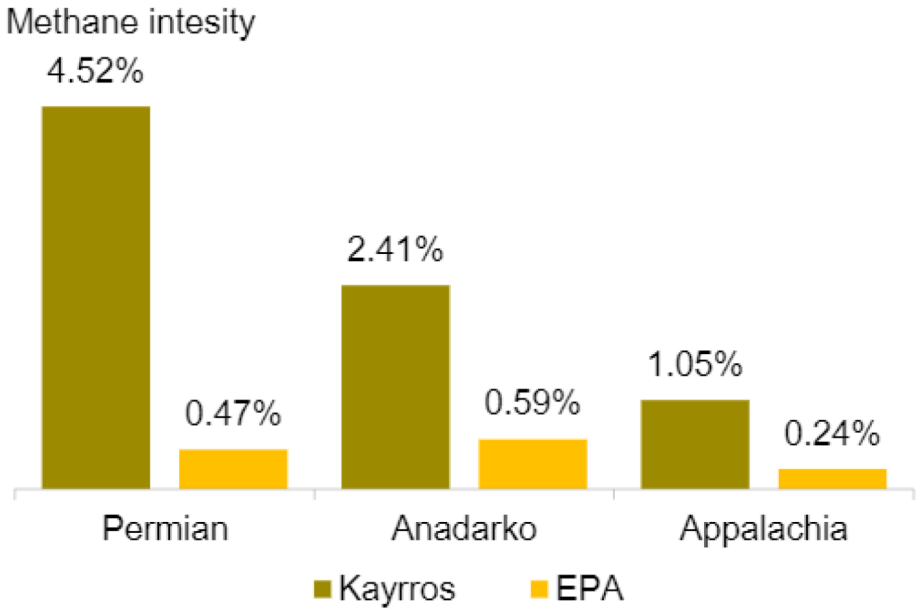
Methane emissions have been under-estimated.



Source: Energy Impact Partners Analysis 2021.

There are significant discrepancies between top-down and bottom up measurements.





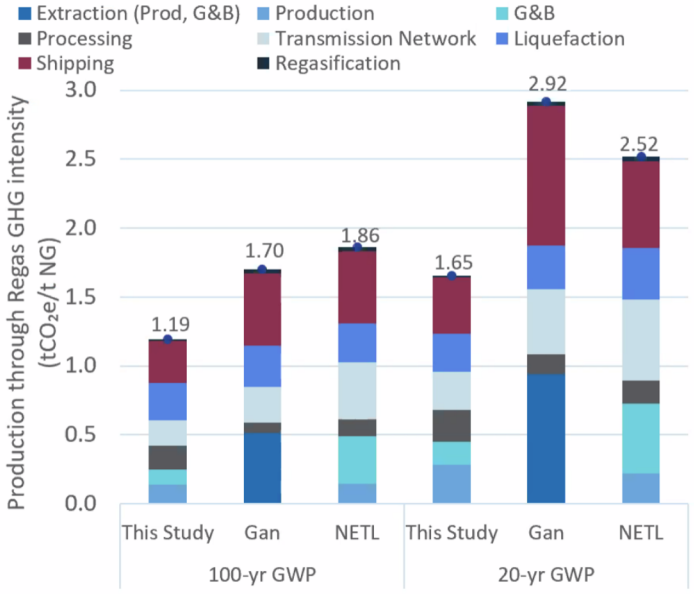
Source: Kayrros 'full inversion', EPA, BloombergNEF.

Sources:
Left: Alvarez, Ramón A., Daniel Zavala-Araiza, David R. Lyon, David T. Allen, Zachary R. Barkley, Adam R. Brandt, Kenneth J. Davis et al. "Assessment of methane emissions from the US oil and gas supply chain." Science 361, no. 6398 (2018): 186-188. Right: Bloomberg.

This has an outsize impact on accurately measuring the supply chain's carbon footprint

Methane emissions ~8-18% of the GHG footprint, and drive total GHGs.

GHG intensity



CHENIERE

Supply chain emissions upstream of end use are significant

- Upstream (prior to power plant) GHG emissions are> 30% of total GHG emissions on a CO_2e basis
- Methane emissions matter: ~ 8-18% of the total GHG emissions (100-yr to 20-yr basis)

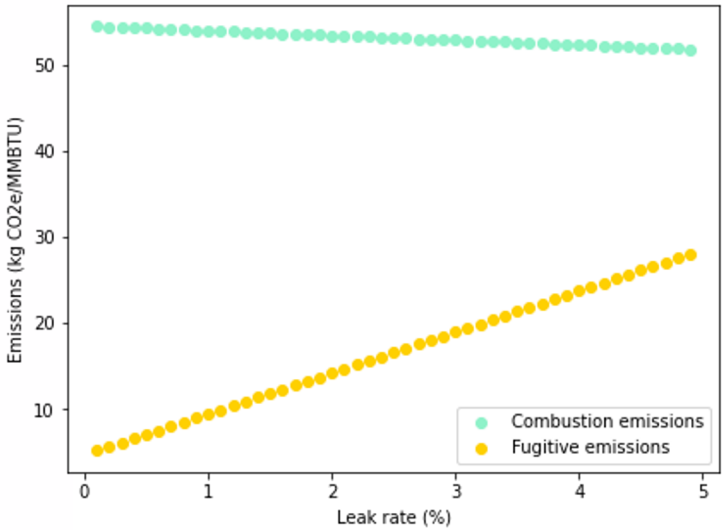
Coal supply chains are also variable due to upstream methane emissions

- Characterizing this variability is important for quantifying the benefits of coal to gas switching

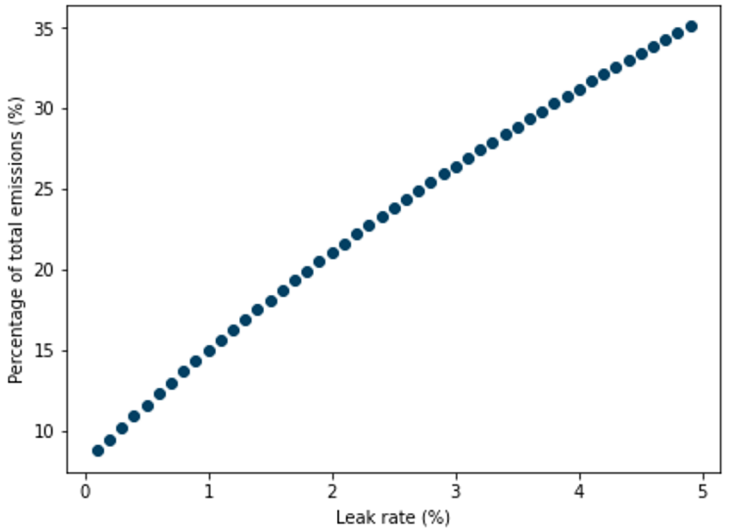
Characterizing the GHG intensity of specific gas supplies via LCAs is critical for informing differentiated gas supply, as well as informing policy and decision makers looking to develop climate strategies

- Ex: a 50% reduction in methane emissions results in 14-24% reduction in lifecycle emissions from production through liquefaction

Leak rate versus emissions

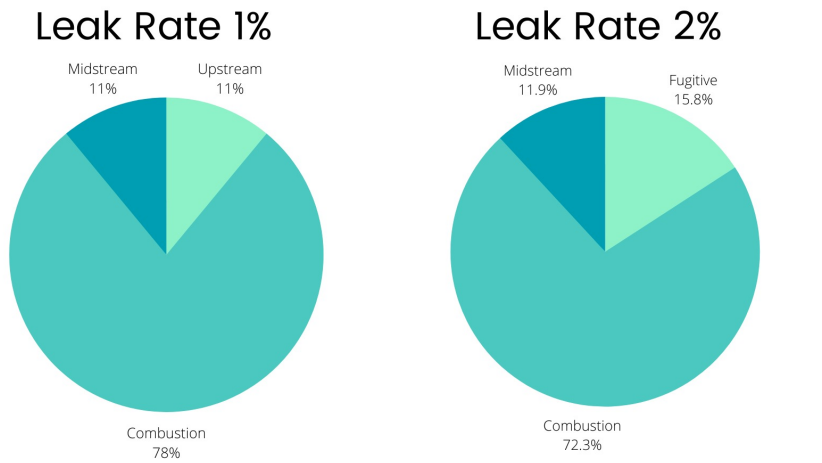


GHG emissions sensitivity to leak rate



Sources:
Left: ACS Sustainable Chem. Eng. 2021, 9, 32, 10857–10867, August 3, 2021, https://doi.org/10.1021/acssuschemeng.1c03307 .
Middle & Right: Project Canary analysis

This has an outsize impact on accurately measuring the supply chain's carbon footprint



Traditionally, measurements have taken two approaches.

Analytical techniques

Technician + camera/sensor

Detection Limit

High

Low

Measurement frequency

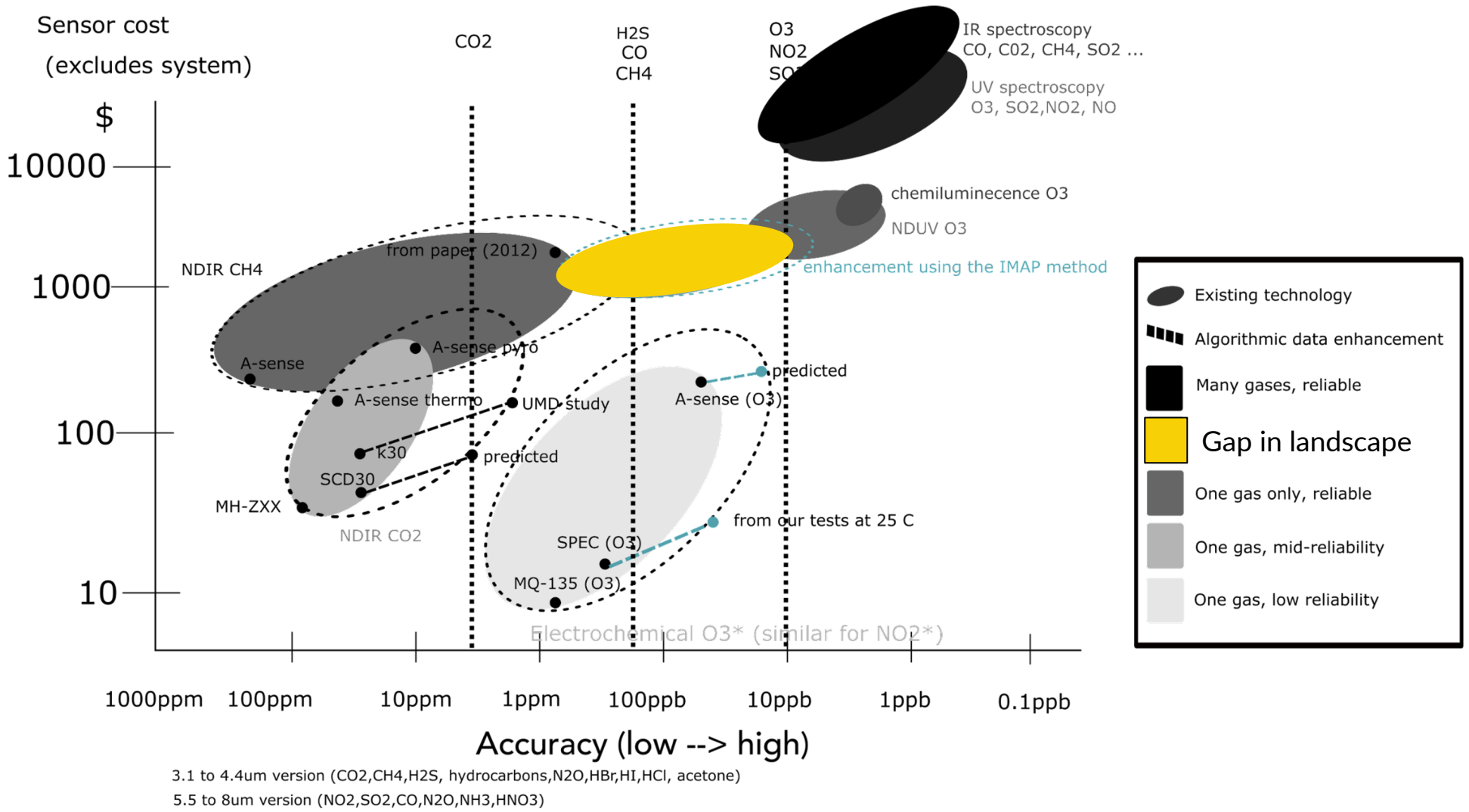
Episodic

Frequent

AVO*

*audio-visual-olfactory inspection

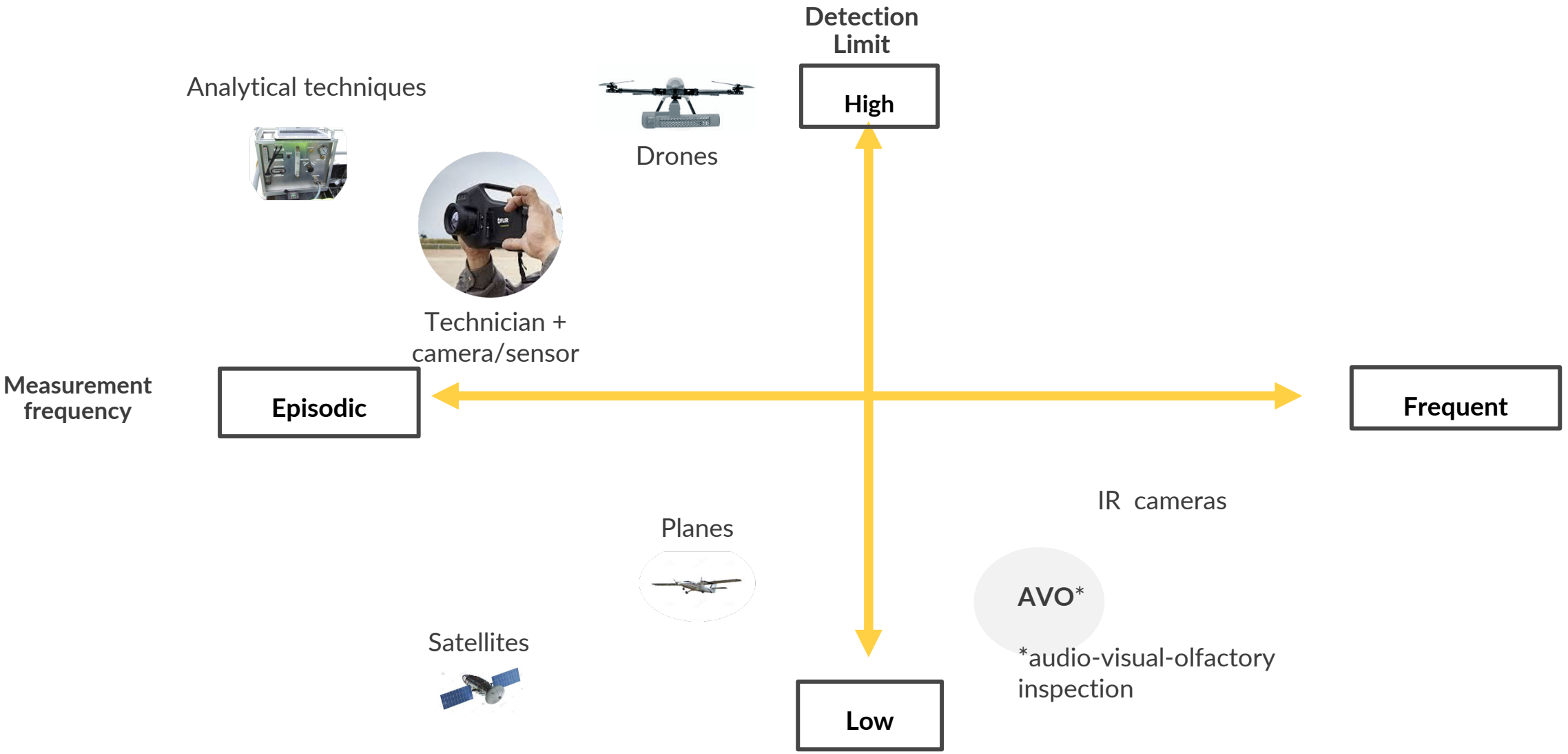
Sensor landscape



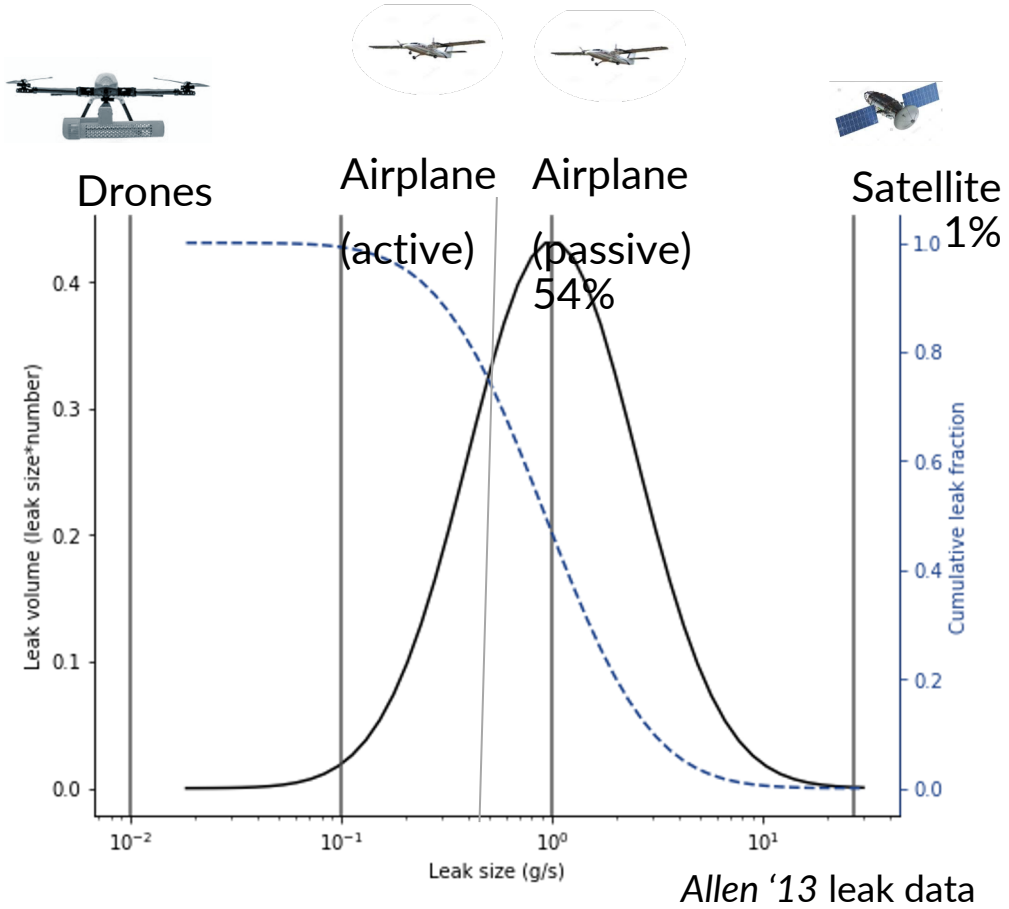
3.1 to 4.4um version (CO2,CH4,H2S, hydrocarbons,N2O,HBr,HI,HCl, acetone)

5.5 to 8um version (NO2,SO2,CO,N2O,NH3,HNO3)

Mobile approaches have began to fill this gap.



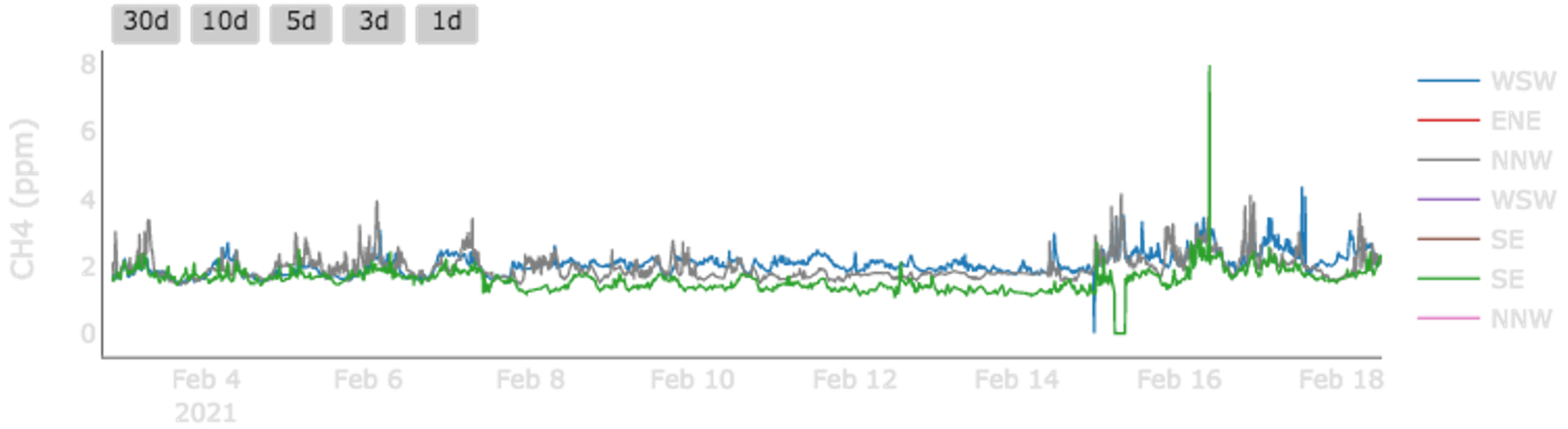
While detection limits play a role here…



Allen '13 leak data

Leak size versus leak volume (left, black) & leak size versus cumulative leak fraction (blue, right). Black curve represents the distribution of leak size versus leak volume from *Allen 2013* field study data.

Mobile approaches are challenged by the intermittency of leaks.

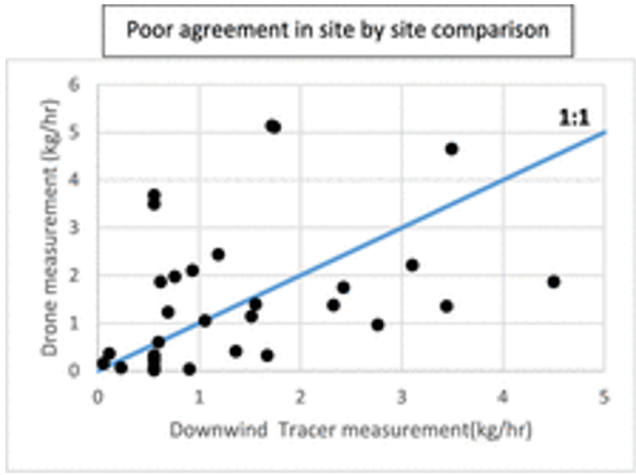


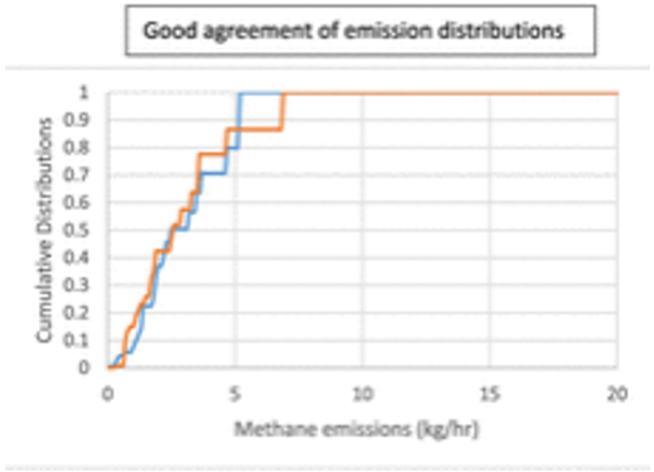
Source: Project Canary data 2021.

Mobile approaches are also challenged by the intermittency of leaks.

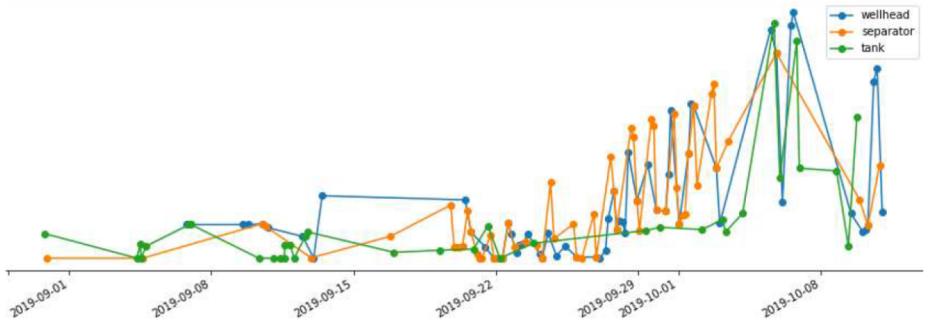
"The **intermittent nature of emissions** from oil and gas production sites **means that** short duration **measurements made within** days, hours, or **minutes** of each other, but not simultaneously, may **lead to very different observations**. "

Tullos, E. E., Stokes, S. N., Cardoso-Saldaña, F. J., Herndon, S. C., Smith, B. J., & Allen, D. T. (2021). Use of Short Duration Measurements to Estimate Methane Emissions at Oil and Gas Production Sites. Environmental Science & Technology Letters, 8(6), 463–467. doi:10.1021/acs.estlett.1c00239





Even these small leaks intermittent leaks grow.



ExxonMobil

Study area ~150 production sites

“High frequency monitoring… may offer faster emissions mitigation and insights into temporal patterns.” - from Tullos, Erin E., Sam Aminfard, Felipe J. Cardoso-Saldaña, David Allen, Isabel Mogstad, Langley DeWitt, Bradley Flowers et al. "*Insights from a Field Trial of Methane Detection Technologies*." AGU Fall Meeting 2019. AGU, 2019.

Our approach to measurement

Field deployment

Human for scale

Anemometer

Ultra-sonic

Methane sensor

TLDAS

Solar panel

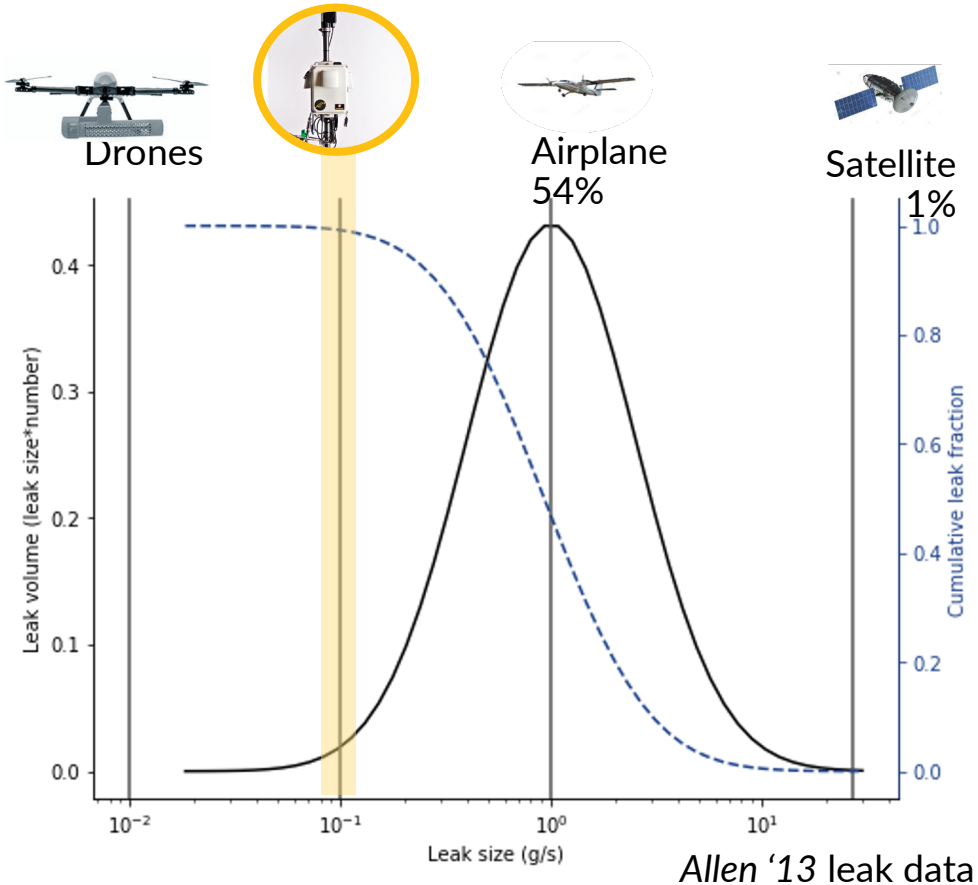
(Self-explanatory)

CANARY X CONTINUOUS MONITORING UNIT SPECIFICATIONS

	Unit	Value
Measurement principle		Tunable Laser Diode Absorption Spectroscopy (TDLAS)
Target gas		CH4
Concentration range	ppm	0-10,000 ppm
Lower detectable limit*	ppm	≤ 0.4
Precision**	ppm	≤ 0.8 ≤ 0.25 with 10 s averaging
Sampling rate	Hz	2
Resolution	ppm	0.01
Accuracy		1-2 ppm over range
Temperature operating range		-10 to 65oC (14 to 150oF)

Notes: *2 sigma, ** 3 sigma,

This fills in the detection “sweet spot”



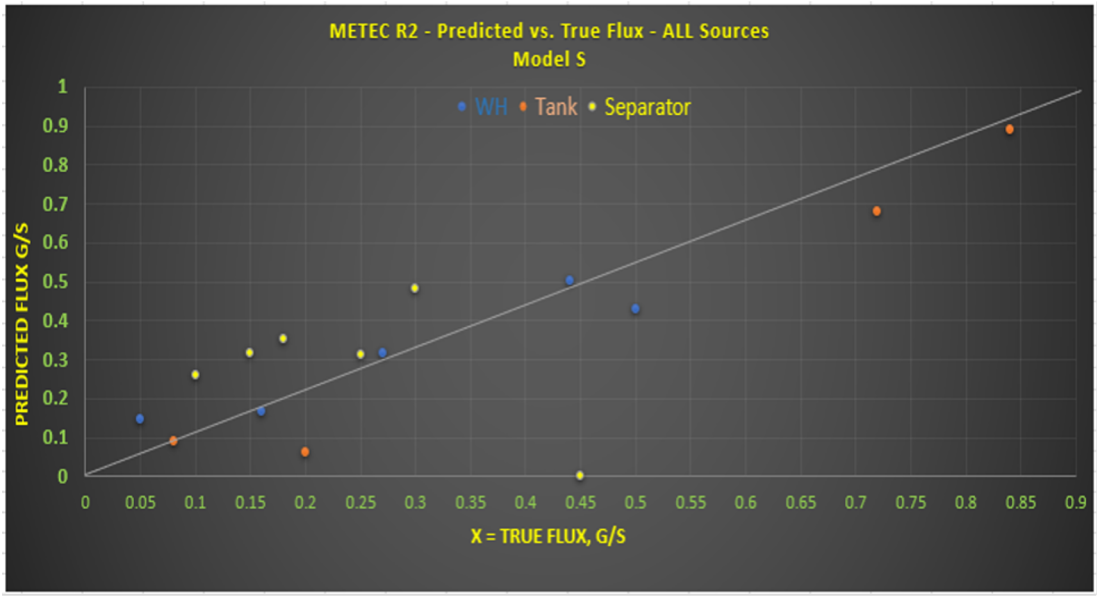
Allen ‘13 leak data

Leak size versus leak volume (left, black) & leak size versus cumulative leak fraction (blue, right). Black curve represents the distribution of leak size versus leak volume from *Allen 2013* field study data.

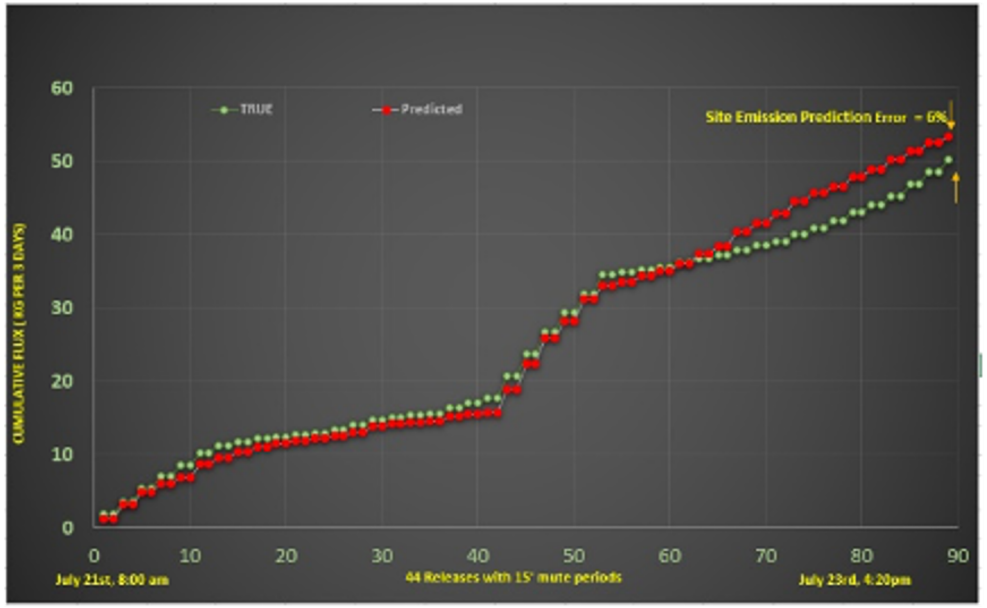
Wind + methane (with appropriate detection limits) leads to accurate emissions quantification

Real-time monitoring through continuous sensing can provide accurate emissions quantification, both on an event basis and an overall basis.

Event-by-event emissions quantification



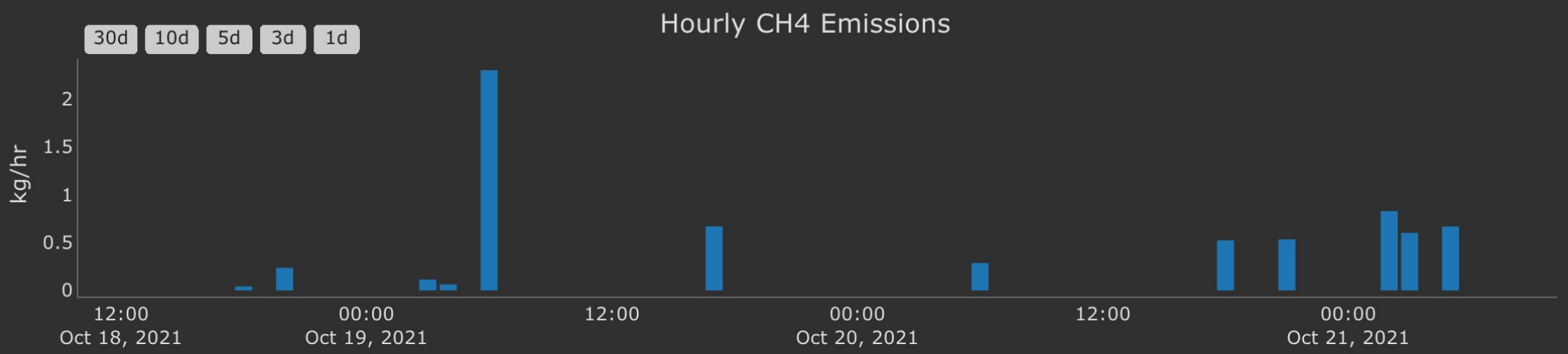
Total emissions flux



Sources: Project Canary 2021. https://www.projectcanary.com/wp-content/uploads/2021/08/METEC-Project-Canary-Abstract9.pdf

Quantification - *Beta*

* Quantification is still in the beta phase and does **NOT** represent total site emissions.



Measured Emissions

Combustor
Total CH4 - 6.3 kg (91.79%)

Well Heads
Total CH4 - 0.6 kg (8.21%)

*** All**
Total CH4 - 6.86 kg

Conclusions

PROJECT CANARY

- **Methane emissions a significant portion of the GHG footprint of the oil & gas supply chain**
- **Measurements critical to accurate carbon accounting**
- **Real-time measurements accurate way to measure small & intermittent leaks**

Anna Scott
Chief Science Officer, Co-Founder
anna.scott@projectcanary.com

https://www.projectcanary.com/