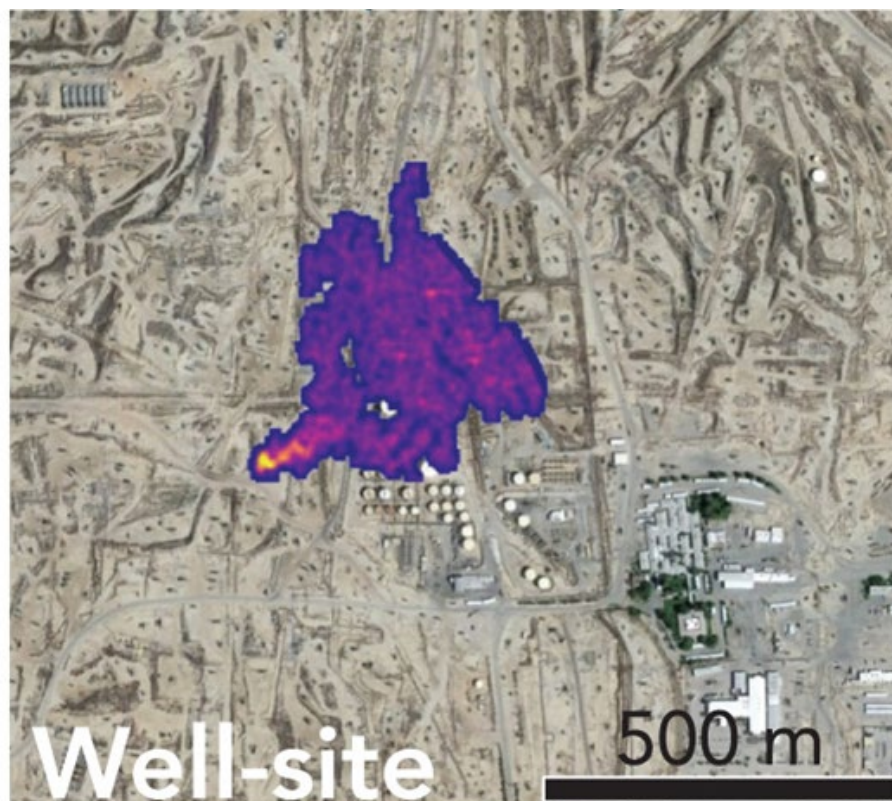




<https://doi.org/10.1021/acsestair.4c00015>



<https://doi.org/10.1073/pnas.2202338119>

The Journey

Chris Moore, PhD
Director, R&D
GTI Energy





The past...



Since 2013 though...

Environmental Science & Technology

Critical Review

Preproduction	Production	Transmission, Storage and Distribution	Use	Well Production End-of-Life
Methane	Methane	Methane	Methane	Methane
BTEX	BTEX		CO ₂	
Non-Methane Volatile Organic Compounds	Non-Methane Volatile Organic Compounds		NO _x	
NO _x				
PM _{2.5}				
Hydrogen Sulfide				
Silica				

Figure 1. Potential species emitted to the atmosphere during specific stages of the natural gas life cycle.

Where we were in 2013/2014

- Emissions may be larger than anticipated (Brandt et al. 2014 Science)
- Reduction technologies can reduce the climate footprint (EPA Gas STAR)
- Need better understanding of emissions
 - Across the life cycle
 - Different Spatiotemporal scales

A review of 20 years of literature on CH₄ leaks⁴² has found that the extent of leakages from North American natural gas systems may be larger than anticipated, yet best management practices and regulation for technologically achievable emissions reduction and effective leak detection and repair programs can significantly reduce the climate footprint of natural gas.⁵⁶ The large recent changes in US EPA methodology and annual emission estimates and disparities in site level and regional level emission measurements highlight the need for additional research to better understand emissions across the natural gas life cycle (see above) and to reconcile emissions measured at different spatiotemporal scales.^{15,22,40,52,53,57,58}

From Moore et al. 2014 ES&T

2013/2014 Recommendations

- Need data on true nationwide extent of methane leaks
 - Inventory of abandoned/orphaned wells
 - Differences by plays/basins
 - Collaborations between scientists, regulators, operators
- Independent scientific data on the true nationwide extent of methane leaks from the production, processing, transmission, storage, and distribution infrastructure, including measurements of flows and fluxes, should be acquired.
 - An inventory of abandoned/orphaned wells should be collected so that emissions can be properly estimated.
 - Measurements on the variation of air emission composition and magnitude by natural gas and oil plays need to be made.
 - Collaborations between independent scientists, regulators, and operators need to be increased to gain access to areas where measurements should be made and to inform effective emissions detection, reduction, and monitoring strategies.

From Moore et al. 2014 ES&T



The "Present"

SOME OF WHAT WE HAVE DONE SINCE 2013 WITH
HELP/FUNDING FROM GOVERNMENT AND OPERATORS

Emissions from Distribution Infrastructure



FINAL REPORT

DOE PROJECT NUMBER DE-FE0029061

GTI PROJECT NUMBER 22070

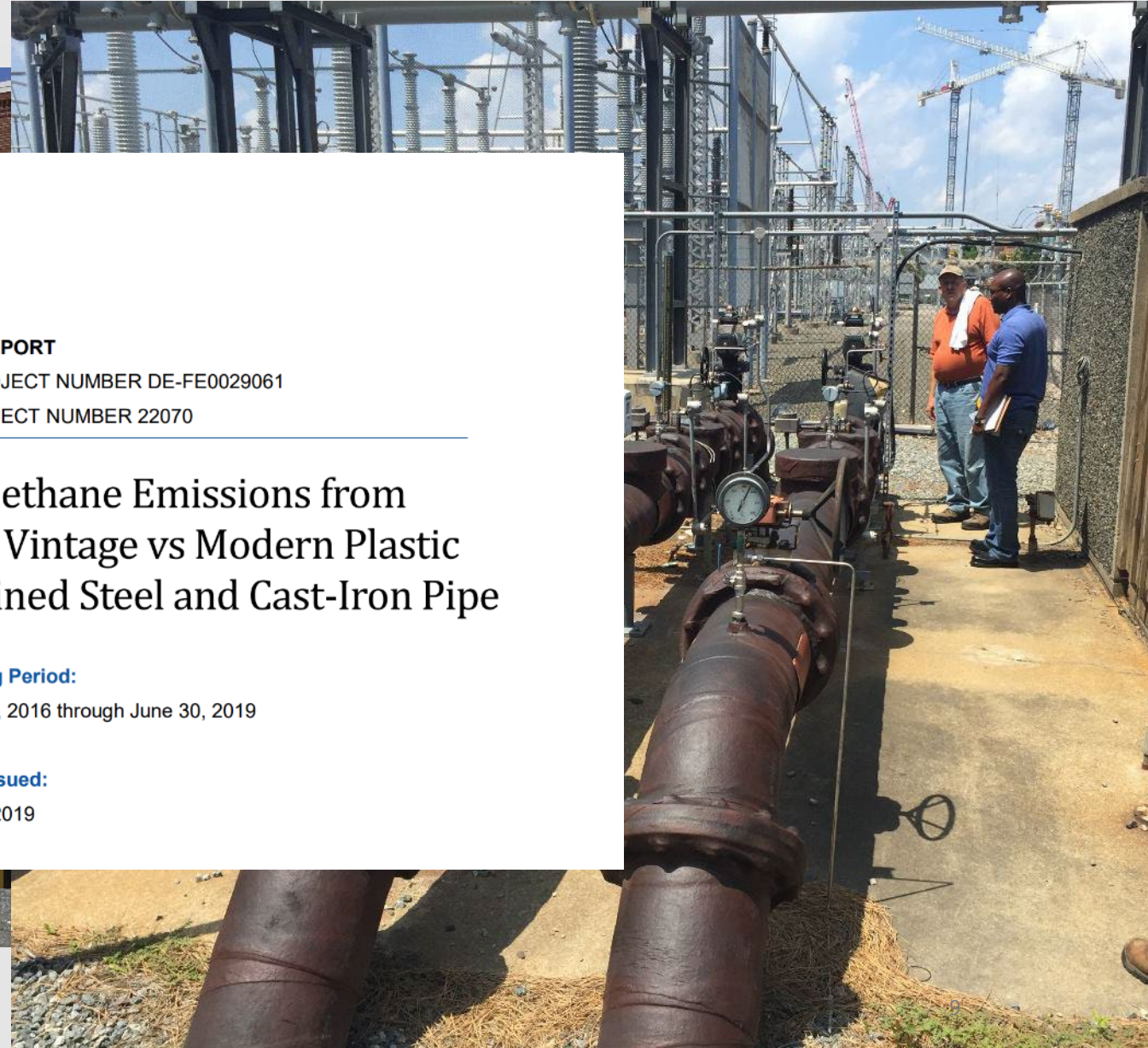
Classification of Methane Emissions from Industrial Meters, Vintage vs Modern Plastic Pipe, and Plastic-lined Steel and Cast-Iron Pipe

Reporting Period:

October 1, 2016 through June 30, 2019

Report Issued:

June 30, 2019



Production Infrastructure/Spatiotemporal

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Article



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Article

Extrapolation Approaches for Creating Comprehensive Measurement-Based Methane Emissions Inventories

Bailey K. Fosdick, Zachary D. Weller, Hon Xing Wong, Abigail Corbett, Yannik Roell, Ella Martinez, Amanda Berry, Natalia Gielczowski, Kristian D. Hajny, and Christopher Moore*

Cite This: <https://doi.org/10.1021/acsestair.5c00455>

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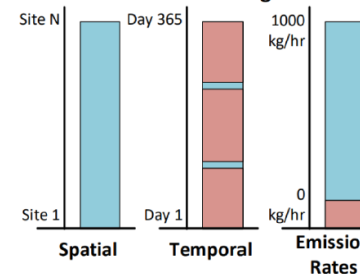
Supporting Information

ABSTRACT: Methane emissions inventories are essential for U.S. oil and natural gas operators to track their progress toward emissions targets, demonstrate the impact of improved operational and monitoring practices, and enable the scientific community to monitor methane budgets at various scales. There has been growing interest in relying less on accounting-style methods and more on direct emissions measurements. However, translating raw emission measurement data, whether from continuous monitoring systems, aerial flyovers, or operational cause analyses, into emissions inventories is nontrivial, and inventory numbers published by operators often lack any information about the methodology used to produce them. In this paper, we introduce the concept of a comprehensive measurement-based emissions inventory, which represents all emissions across the entire time frame, across all assets, and of all emission sizes for the target scope. We introduce practical extrapolation methods to account for incomplete measurement data across time, space, and emission sizes and focus on the impact that different extrapolation methods can have on the resulting emissions estimate. Understanding these methods is essential to create defensible and comparable emissions inventory reports that adhere to reporting frameworks such as Veritas and the Oil and Gas Methane Partnership 2.0.

KEYWORDS: methane, extrapolation, measurement based inventory, greenhouse gas inventory, oil and gas



Aerial Coverage



PSN Coverage

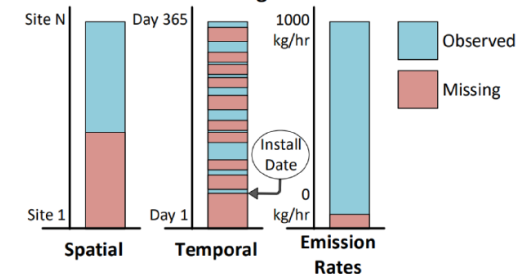


Figure 1. Qualitative diagrams showing the relative coverage of the aerial survey and the PSN data across each dimension. The aerial survey data consists of two campaigns covering all sites (Spring and Fall, 2023). PSN were deployed throughout the year, creating an additional unmonitored period for many sites at the beginning of the year.



Better understanding of Basin Emissions



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Challenges with Developing a Measurement-Based Basin Methane Intensity Estimate: A Case Study from the Haynesville

This is a Preprint and has not been peer reviewed. This is version 1 of this Preprint.

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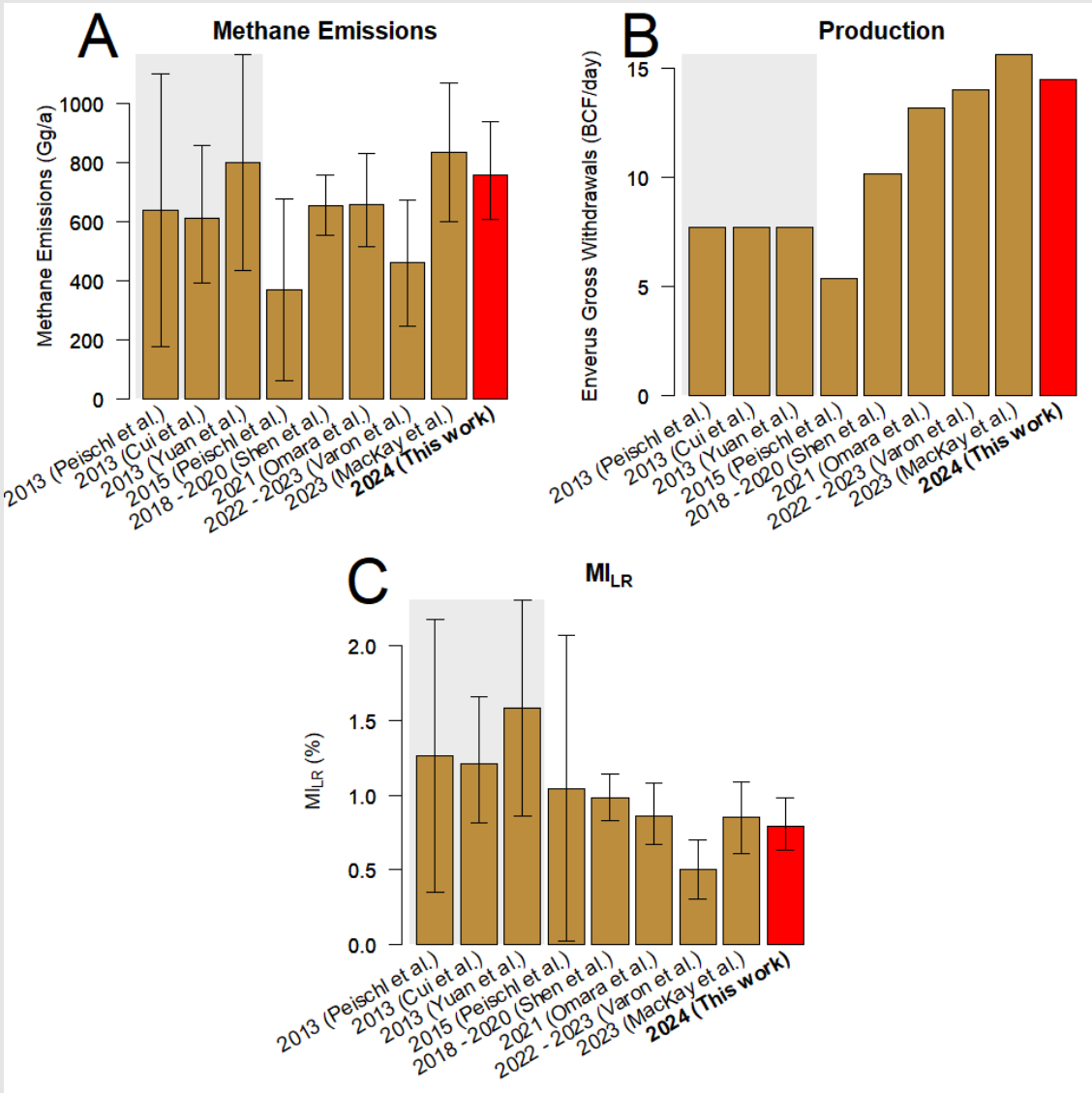
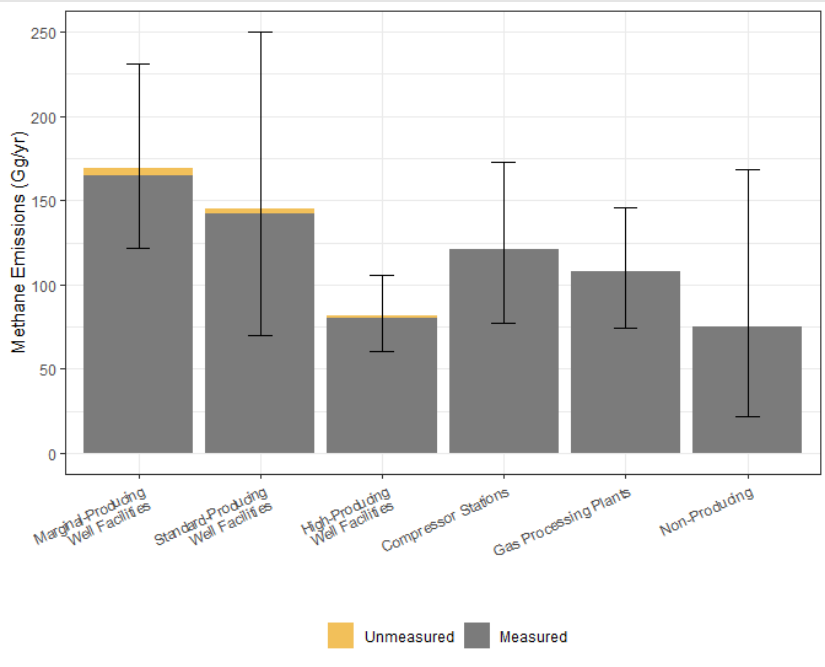
1Challenges with Developing a Measurement-Based

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Technologically Achievable Emissions Reduction

FINAL REPORT

Technology Roadmap for Compressor Station Methane Emissions and Mitigation Scenarios

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Carolyn LaFleur

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June 2025

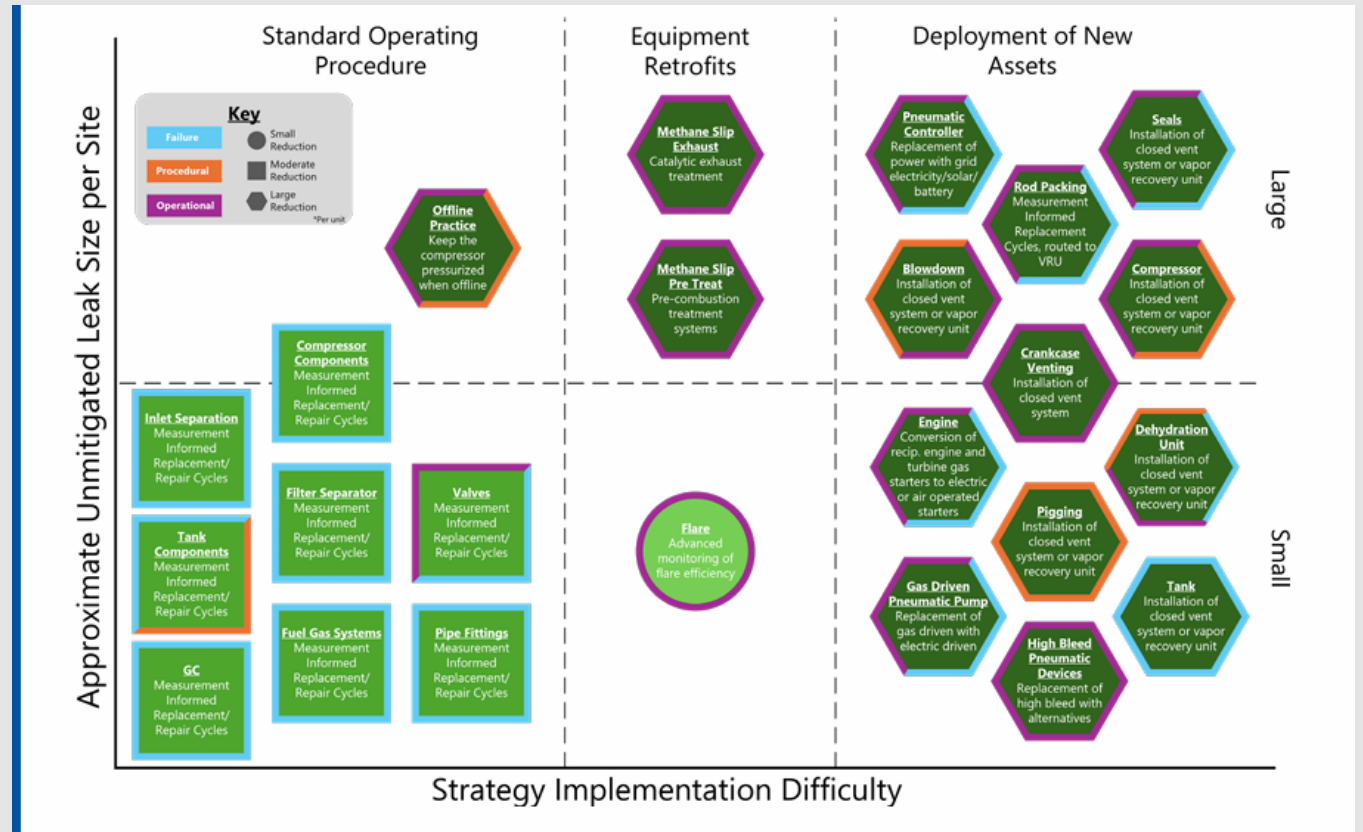
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for

U.S. Department of Transportation, Pipeline and Hazardous Materials Safety
Administration

Agreement 693JK32310003POTA



Measurements Possible in More Areas

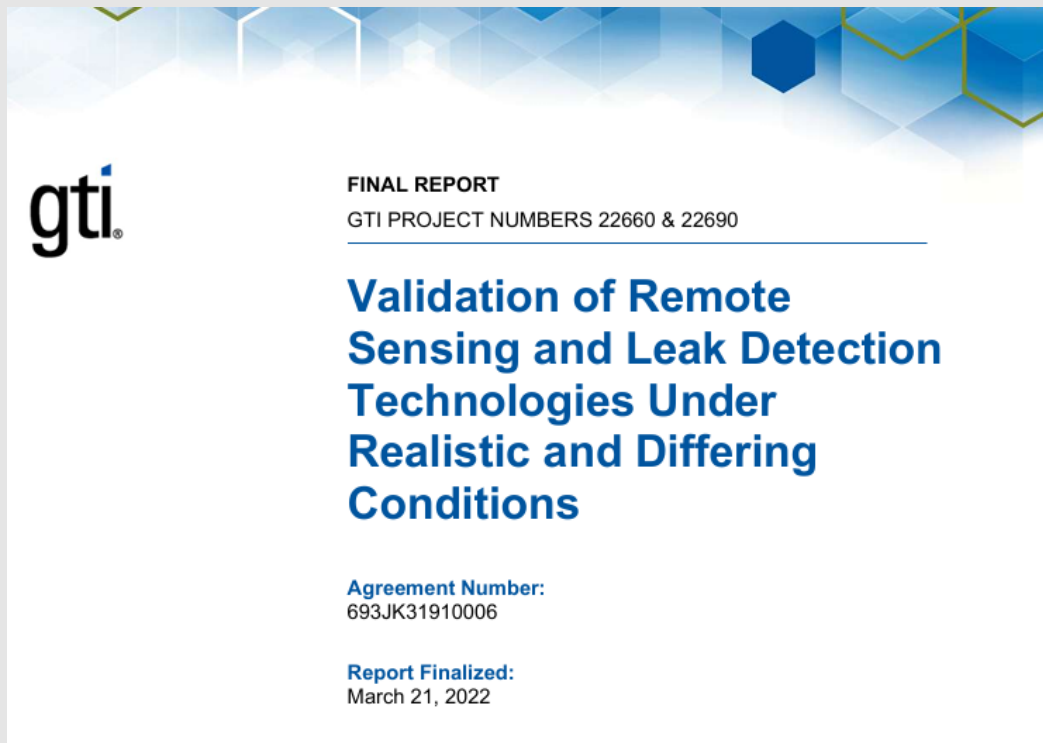


Figure 14. Aboveground equipment at the utility owned transmission ROW site.

So I would say we did a good job of predicting the future...

And we're getting there

But still have a long, exciting journey

And that's what this meeting is for...

