

DOE NETL: Methane Emissions Quantification

Project Award: DE-FE0031702



Quantification of Methane Emissions from Marginal (Low Production Rate) Oil and Natural Gas Wells

BACKGROUND

PROBLEM STATEMENT

There are more than 1.1 million oil and natural gas wells in the U.S., of which about 770,000 (~70%) are considered marginal. Debate continues among concerned stakeholders regarding whether marginal well sites should be subject to or exempt from fugitive emissions monitoring and associated leak detection and repair (LDAR) requirements.

PROJECT OBJECTIVE

Collect and evaluate representative, defensible and repeatable data and draw quantifiable conclusions on the extent of methane emissions from marginal wells across oil and gas producing regions of the U.S., and to compare these results to published data available on the emissions from non-marginal wells.

DATA SOURCE STATUS ASSESSMENT

Key data gaps were identified based on a thorough review of published sources and partially addressed by information derived from a broad survey of oil and gas well operators.

■ **Literature Review.** Findings of previous studies indicate that existing site-level emissions measurements and “activity data” (i.e., related to operations) from previous studies largely underrepresent and are not enough to accurately characterize marginal well emissions.

■ **Confidential Production Operator Survey.** Survey responses representing over 86,000 sites across 29 basins in 23 states indicate that *site characteristics most likely to relate to methane emissions* include i) the *main product* generated at the site, ii) the *production rate* of oil and/or natural gas, iii) the “*size*” of the site defined in terms of the total equipment count (wells, tanks, separators, etc.), and iv) the *frequency of liquids unloadings*. Figure 1 depicts the geographic distribution of **48 site categories** distinguishing the variability of these factors, as represented in the results of the operator survey, where each color represents a unique category and similar (but distinct) colors visually represent more closely related categories.

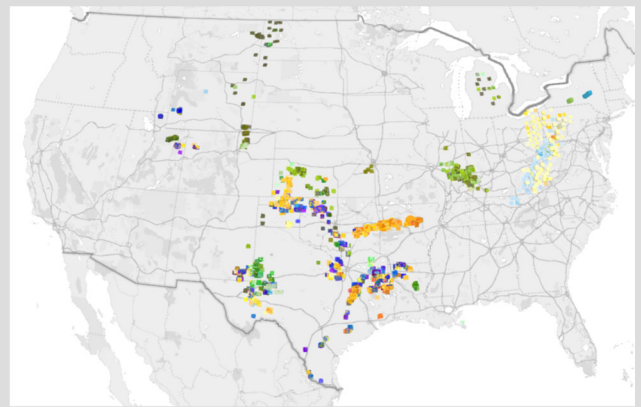


Figure 1. Marginal well sites represented in operator survey results
Sites primarily producing dry gas are shown in colors ranging from yellow to red, wet gas sites in purple/blue, and oil sites in shades of green. Within each product category, distinct colors represent differences in equipment count and production rate.

REGIONAL FIELD CAMPAIGNS

Three 5-week field investigations will be performed in multiple regions/basins to capture the variability and diversity of both physical and operational conditions, especially in areas with large numbers or a high density of marginal wells, or where marginal wells account for a large percentage of regional production.

■ **Field Campaign 1.** Completed in October-December 2019 in the *Appalachian, Illinois, and Forest City Basins*. The Appalachian Basin is largely dominated by natural gas production, whereas oil production is predominant in the Illinois, and Forest City Basins. Site populations in other regions are much more diverse and not well represented by sites in these basins.

■ **Field Campaign 2.** Originally planned for April-May 2020 in the Permian and Anadarko Basins, postponed due to Covid-related travel and site access restrictions. Two weeks of field work in the *Upper Green River, Piceance, and Anadarko Basins* are scheduled to commence on Oct 26, 2020. Tentative plans call for the remaining 3 weeks to be spent in the *Permian and Palo Duro Basins* in early 2021.

■ **Field Campaign 3.** Although included in the scope of work, federal funds have not yet been obligated to allow planning or execution of the final five weeks of field work planned to include additional basins in the Rocky Mountains region, such as the *Uintah and Denver-Julesburg Basins*, and, if possible, *additional portions of the Permian and Anadarko Basins* not reachable in the second field campaign.

There is broad consensus among scientists with DOE, EPA, industry and environmental stakeholders that, due to the diversity and extensive geographic distribution of marginal wells across the U.S, there is a strong need for the full scope of the regional field campaigns to be carried out.



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FIELD CAMPAIGN 1 SUMMARY

■ **Visited Field Sites.** Facilities were selected for measurement using *geographically clustered, random sampling*. Escorted access to sites was provided by participating host operators, whose identities and site locations remain confidential, per signed access agreements.

146 natural gas sites and 87 oil sites were visited. In all, 228 of the sites exhibited marginal production at an average rate of 2.5 BOE per day of combined oil and gas. Five non-marginal sites producing 96 MCFD (16 BOE/day, “marginally non-marginal”) to 4,000 MCFD (667 BOE/day) of dry gas were visited in the Appalachian Basin. No non-marginal oil production sites were available in any of the visited regions. Besides emissions screening and measurements, *detailed activity data*, including major equipment counts and oil and gas production rates, were documented at each visited site.

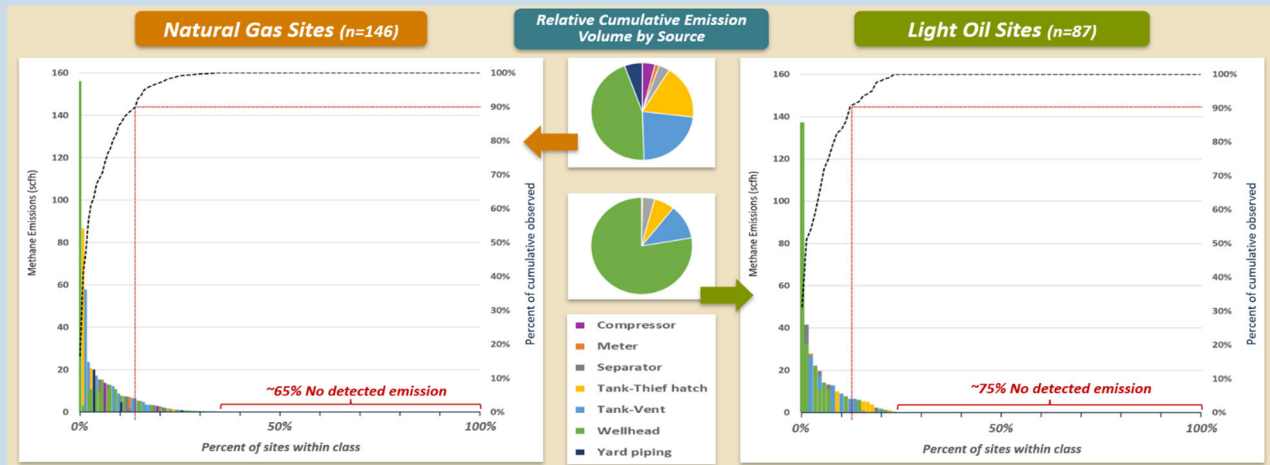


Figure 2. Site-wide methane emissions

■ **Emissions Screening and Measurements.** Gas emissions were detected using an *optical gas imaging* camera and quantified, where possible, using a *high flow sampler* in conjunction with gas composition-specific analyses. One emission was measured using the *downwind tracer flux method*.

■ **Frequency of Detected Emissions.** Table 1 summarizes the frequency of detected emissions, which varied widely and exhibited *no discernable pattern relative to observed equipment types or type of production*. On a site-wide basis, no emissions were detected at ~65% of natural gas sites and ~75% of oil sites (see Figure 2). Approximately 90% of the cumulative detected emissions detected are attributable to ~12% of the visited sites for both types of production.

■ **Magnitude of Detected Emissions.** The emission rate measurements exhibit the long-tail behavior commonly observed in air emissions studies. Approximately 90% of observed emissions were less than 13 standard cubic feet per hour (scfh).

Table 1. Summary of observed equipment and detected emissions

Equipment Category	Natural Gas Sites (n=146)			Light Oil Sites (n=87)		
	#Equipment Observed	#Emissions Detected	Emission frequency	#Equipment Observed	#Emissions Detected	Emission frequency
Wellheads	165	32	19%	97	13	13%
Meters	157	3	2%	7	2	29%
Compressors	4	3	75%	2	0	0%
Separators	130	4	12%	28	4	14%
Dehydrators	1	0	0%	0	0	-
Tanks	157	-	-	68	-	-
Thief hatches	-	4	3%	-	8	12%
Vents	-	16	10%	-	14	21%

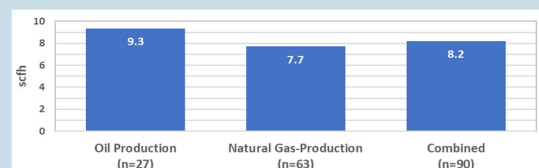


Figure 3. Average detected methane emission rates

The top 10% of emission sources contributed 72% of the total measured emissions, and the top two emission sources alone accounted for 40%. Figure 3 summarizes the overall average measured methane emission rates.

PENDING COMPREHENSIVE DATA EVALUATION

Once qualified datasets from all regional field campaigns are fully developed, comprehensive exploratory and statistical data analyses will be performed to identify *key groupings of sites in the studied regions and their distinguishing characteristics and emission profiles* (see Figure 4). Data analyses are ongoing; therefore, the limited analysis and representations of data shown here, and any interpretation of the same, should be considered preliminary. It is important to recognize that the results presented here represent only a small fraction of the diversity of marginal well site characteristics present around the country (see Figure 1). Further investigation of sites exhibiting a broader range of product types, production rates, and site equipment counts in the remaining two field campaigns will provide more representative results and more meaningful conclusions upon completion of this project.

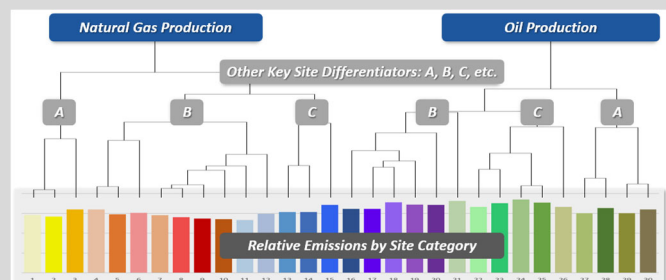


Figure 4. Conceptual example of data analysis
Besides product type, other key differentiators may include “size” (equipment count), production rate, or other factors.

A Technical Advisory Steering Committee (TASC), consisting of stakeholders from industry, academia, regulatory agencies, and non-governmental organizations, provides recommendations and feedback on project activities, such as strategy development, field implementation, data analysis, and study conclusions, throughout the project.