Quantification of Methane Emissions from Marginal (Small Producing) Oil and Gas Wells

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Low production oil/gas wells
   - Produce <90 MCF gas or <15 bbl oil per day (EPA 2016)
   - High production costs (IOGCC 2016)

Continental U.S. ~770,000 marginal wells represent >65% of wells and >8% of total O&G production (boe basis; IOGCC 2016)

Most wells will "grow up" to be marginal producers

Issue

- Marginal well sites are subject to costly leak detection and repair requirements (LDAR)
- EPA decisions based on very limited study data

Key Objective

- Support common sense regulation based on defensible data
STUDY QUESTIONS TO ANSWER

› How do marginal vs. non-marginal wells compare in terms of:
  • Production rates?
  • Type and quantity of equipment?
  • Frequency/timing of episodic high-emission events?
  • Equipment type/age/condition?
  • Absolute contribution to total emissions?

› Correlations of site characteristics to emissions

› How significant are marginal wells emissions?

KEY POINT: Need equipment-specific analysis to compare marginal vs. non-marginal wells
OVERALL STUDY APPROACH

› Desktop Study / Data Mining
  • Literature and operator surveys
  • Database compilation/statistical analysis

› Regional Field Investigations
  • Statistically-based sampling design
  • Multiple production basins/regions
  • Established measurement protocols
  • Statistical data analysis

› Messaging and Communication
  • Engagement with industry, state regulators, EPA, etc.
  • Project reporting
WELL SITE DATA – Data Blinded Operator Survey

› Site location
  • Basin, state, county, etc.

› Activity data
  • Production type and rate
  • Liquids unloading, associated gas disposition
  • Emissions monitoring

› Major equipment
  • Active/inactive wells
  • Tanks, separators, dehydrators, etc.
  • Flares/thermal combustors
  • Equipment components (e.g., pneumatic devices)

RESPONSES RECEIVED: ~86,700 wells, 29 basins, 23 states
**MARGINAL PRODUCTION SITE CLASSIFICATION CATEGORIES**

<table>
<thead>
<tr>
<th>Equipment Count</th>
<th>Dry Gas</th>
<th>Wet Gas</th>
<th>Light Oil</th>
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**Key Differentiators**

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<tr>
<th>Categories</th>
<th>Dry Gas</th>
<th>Wet Gas</th>
<th>Light Oil</th>
<th>Other*</th>
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<td>Main Product</td>
<td>0-1</td>
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<td>&gt;4-8</td>
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<td>Production Rate (BOE/day/site)</td>
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<tr>
<td>Well Pad Size (Pieces of equipment)</td>
<td>Small (1)</td>
<td>Medium (2-3)</td>
<td>Large (4-5)</td>
<td>Extra-Large (&gt;5)</td>
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<tr>
<td>Disposition of Associated Gas (oil wells)</td>
<td>Recovered</td>
<td>Vented</td>
<td>Combusted</td>
<td>Other/NA</td>
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</table>

* Other main products are CBM and heavy oil; these products represent a small portion of the survey responses.
REGIONAL FIELD CAMPAIGNS

› Visited >500 “sites” with 15 host operators
› Sites located in 8 basins and 13 states
› 629 wells (~10% non-marginal)
FIELD WORK PLANS

› Field Investigation Design
› Site Selection
   • Representative populations provided by host operators
   • Geographically clustered Random sampling
› Technology specifications (Equipment, methods, protocols, etc.)
   • Emissions Screening - Identify key emission sources
   • Emissions Measurement - Quantify emission composition from representative emitting sources
› Data analysis (criteria, procedures)
FIELD CAMPAIGN “SITES” VS. WELLS

PRELIMINARY

# “Sites”
# Wellheads
# Detected emissions

Count

Marginal  Non-Marginal  Marginal  Non-Marginal  Marginal  Non-Marginal  Marginal  Non-Marginal  Marginal  Non-Marginal  Marginal  Non-Marginal
Gas  Non-Marginal  Gas  Oil  Oil  Gas  Oil  Oil  Gas  Oil  Gas  Oil
Anadarko  Appalachian  IL/FC  Permian  Rockies

0  20  40  60  80  100  120  140  160  180
FIELD DATA COLLECTED — Activity Data

› Weather Data
› Major Equipment Counts
› Operator “Interview”
   • Production type and rates
   • Liquids unloading details
   • Disposition of associated gas
   • Emissions monitoring
   • Operating conditions typical/variable?
› Component Counts (time permitting)

*Site-specific data remains confidential*

Site-level activity data to characterize the significance and representativeness of conditions observed, and not observed, at the time of each site visit.
FIELD SITE CHARACTERISTICS

› Equipment Age Variation:
  • Wellheads: 2 – 79 years old
  • Separators: 2 – 72 years old

› Equipment Count Variation:
  • 0 – 25 Wellheads
  • 0 – 11 Separators
  • 0 – 10 Meters
  • 0 – 9 Tanks
  • 0 – 13 Tank Vents
  • 0 – 8 Tank Hatches
  • 0 – 5 Emission Control Devices
  • 0 – 3 Gas-Powered Engines
OBSERVED EQUIPMENT – Combined Field Campaigns

PRELIMINARY

Count

- Wellheads
- Tanks
- Separators
- Meters
- Heaters & Thermal Units
- Compressors
- Dehydrators
- Flares
KEY EARLY RESULTS – Field Campaign 1

**Gas Sites (n=146)**

- Percent of sites within class: ~65% No detected emission

**Light Oil Sites (n=87)**

- Percent of sites within class: ~75% No detected emission
Conceptual example of data analysis to develop representative emission profiles for distinct site populations. Besides product type, other key differentiators may include "size" (equipment count), production rate, and other factors as determined through further analysis.
Data collection complete – Data processing/analysis underway

Key early findings:
- “Site” definition can be ambiguous due to diverse well pad and production system configurations across multiple regions
- Majority of sites visited exhibited no detected emissions
- Detected emissions exhibit characteristic “fat-tail” distribution, where a small fraction of sites contributes a large majority of observed emissions

Next Steps
- Exploratory analysis of complete dataset
- TASC (advisory) calls – mid September 2021
- Project report – December 2021
Thank you – Questions?

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APPENDIX

› Benefit to the Program
› Project Overview
› Organization Chart
› Gantt Chart
The DOE-NETL program goal addressed is *Methane Emission Quantification*, with research focused on characterization of emissions from specific components of the oil and natural gas production and processing chain.

**Project benefits to the program include:**

- Quantification and characterization of methane emissions from marginal well site-specific components (wellheads, valves, piping, separators, compressors, storage tanks, etc.) will address varied regulatory concerns and support EPA greenhouse gas reporting and inventory programs.
- Study findings will facilitate identification and implementation of appropriate best management practices for continued reliance on traditional oil and gas resources while enhancing environmental protections.
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.

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

<table>
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<tr>
<th>Task / Description</th>
<th>2019</th>
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<td>Data Source Status Assessment and Workplans</td>
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- **work complete**
- **work pending**