

Natural Gas Methane Emissions in the United States Greenhouse Gas Inventory: Sources, Uncertainties, and Opportunities for Improvement

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JISEA Report

With a focus on methane emissions from the natural gas (NG) sector, the purpose of this report is to:

1. Summarize methods and results of the U.S. Greenhouse Gas Inventory (GHGI)
2. Identify potential gaps and barriers to improvement
3. Identify opportunities to improve accuracy.

Observations and suggestions in this presentation focus on providing an overview of recommendations.

- Additional detail on these recommendations can be found in the report.

This report is one of several recent JISEA studies on natural gas, including:

- *Potential Cost-Effective Opportunities for Methane Emission Abatement* (natural gas, oil, and coal)
- *Controlling Methane Emissions in the Natural Gas Sector: A Review of Federal & State Regulatory Frameworks.*



Estimating U.S. Methane Emissions from the Natural Gas Supply Chain: Approaches, Uncertainties, Current Estimates, and Future Studies

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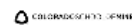
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Technical Report
NREL/TP-6A50-62820
August 2015

Contract No. DE-AC36-08GO28308



The U.S. GHGI: A Critical Resource

The U.S. Environmental Protection Agency publishes the U.S. GHGI; many agencies, organizations, and researchers rely on its results for analyses and decision making.

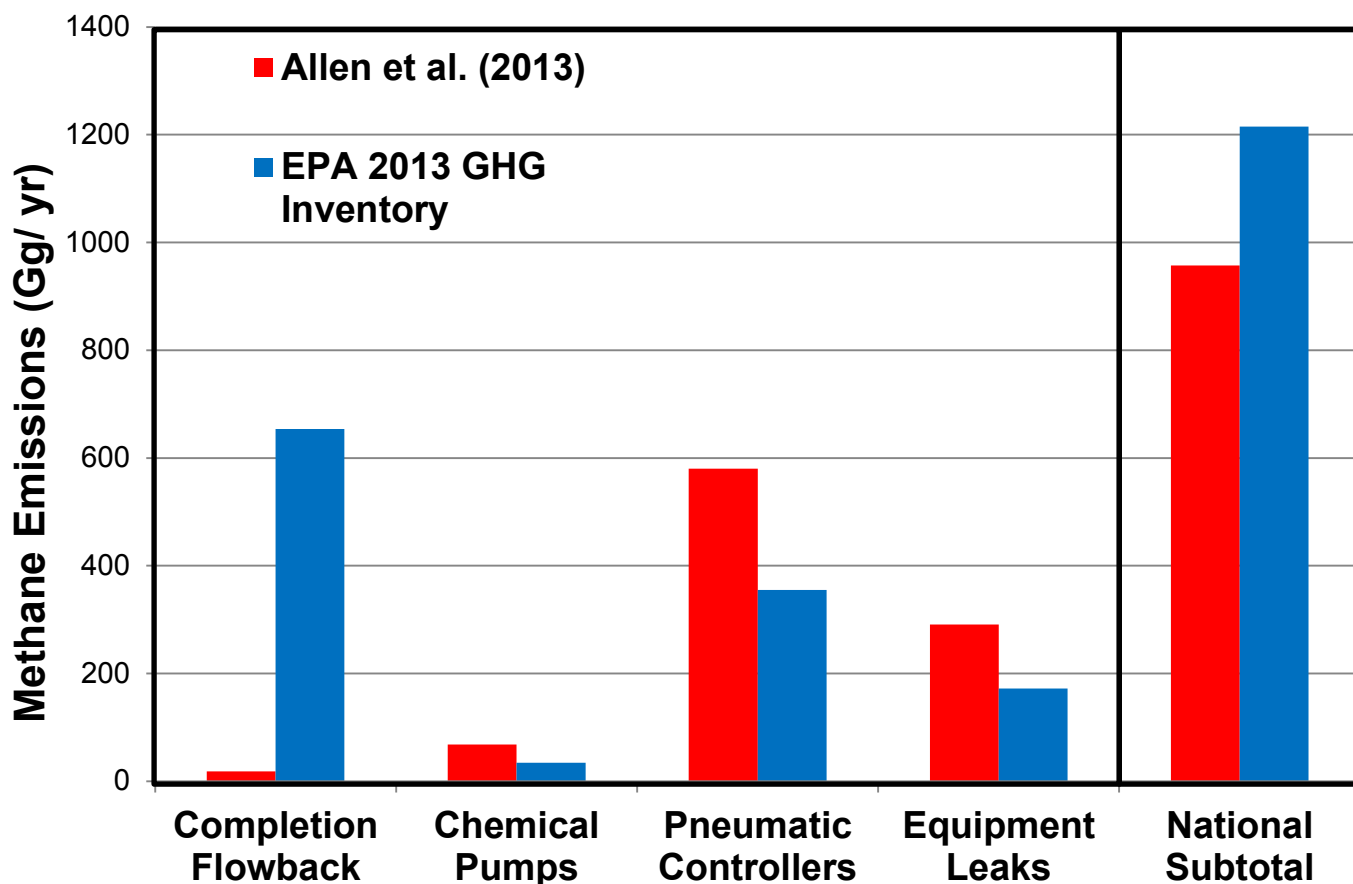
The U.S. GHGI is a critical resource for:

- Understanding the U.S. contribution to global climate change
- Tracking trends in GHG emission sources and sinks
- Identifying and prioritizing abatement opportunities within the United States
- Informing policy and investment decision making.

Source Prioritization is Affected by Accuracy of Source-Level Emission Estimates

Even when the sum of measured emissions from different sources is equivalent to the inventory, is it due to compensating errors?

(Allen et al. 2013)



Top-Down and Bottom-Up Studies: Roles to Improve Inventory

Both top-down (TD) and bottom-up (BU) studies have uncertainty and potential for inaccuracy; neither is “truth.”

Both have roles to improve inventory, e.g.:

- **TD:** Useful as comparison to inventory estimates, any differences could help generate hypotheses
- **BU:** Measurement studies can update outdated emission factors (EFs).

POTENTIAL IMPROVEMENT:

Improve capability of TD measurements to verify inventory, e.g.:

- *Improve source attribution to better align TD and BU study system boundaries*
- *Improve understanding of non-O&G methane sources, especially ones that confound current attribution methods*
- *Improve ability to align measurements across scales, e.g., from regional to facility.*

Inventory Improvement Through BU Measurement Studies

Challenges with currently used EFs:

- Not representative
 - Outdated
 - Sampling bias
 - Sample size
 - Mean emission factors (EFs) capture fat tail?
 - All salient dimensions of emission variability captured?

POTENTIAL IMPROVEMENTS:

- *Update EFs for prioritized emission sources categories*
- *Focus effort of new studies on ensuring robust sample size, strong sampling design to capture source variability and minimization of self-selection bias*
- *Leverage available evidence to explore how to characterize emission variability within the EF metric*
- *Explore regional variability and along other dimensions.*

Inventory Improvement for Activity Factors

Most efforts to improve the inventory have focused on EFs; activity factors (counts) also need attention:

- Data sources
 - GHGRP or new ones
- Methods – transparency, simplicity, and accuracy
- Balance the need for consistent time series with the need to improve current accuracy.

POTENTIAL IMPROVEMENTS:

- *Develop new data sources to improve accuracy, completeness, and methodological simplicity*
- *Develop methods for quantification of activity factor uncertainty.*

Inventory Improvement: Completeness and Structure

Prioritized gaps in current knowledge, e.g.:

- Abandoned wells
- Measurements on gathering pipelines
- “After the meter” leaks at site of end use
- Well work-overs that are not recompletions*

Inventory structure

- Currently organized sectorally, which creates challenges when comparing to a measurement representative of a certain spatial domain
 - Oil and gas wells in the same area
 - Associated gas
- Certain segments are grouped, e.g., gathering with production.

POTENTIAL IMPROVEMENTS:

- **Fill prioritized source gaps in GHGI**
- **Align future studies to the structure of the GHGI for easier incorporation OR**
- **Consider restructuring the inventory to better capture robust results of recent studies**
- **Gridded inventory to enhance measurement-based validation.**

Uncertainty Quantification

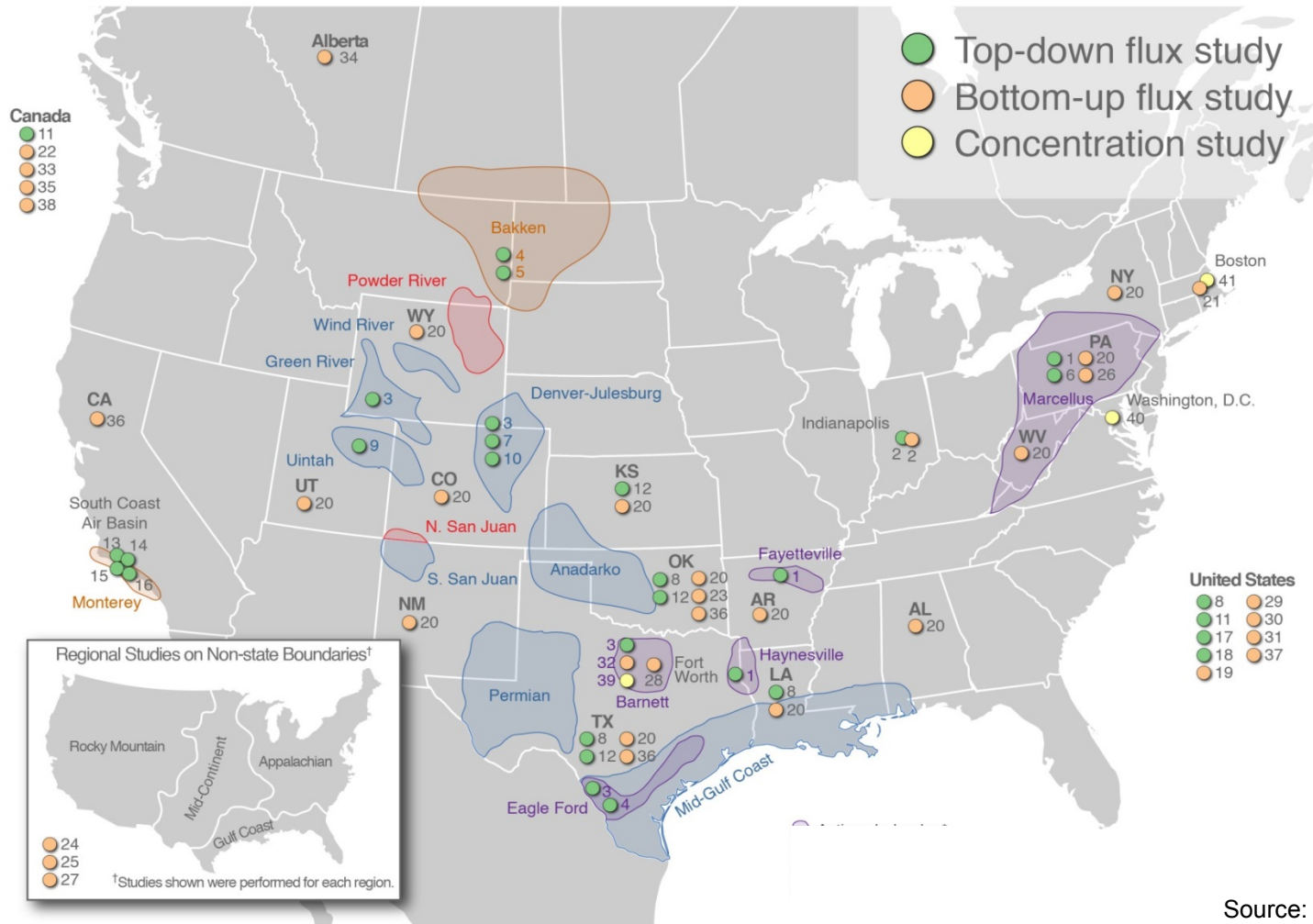
Uncertainty quantification is critical for informed decision making, communication, and verification with measurements. Currently, the GHGI:

- Uses Monte Carlo parametric uncertainty quantification, with lognormal distributions assumed in almost all cases
- Reports an uncertainty range that hasn't changed since 2010
- Uses expert judgment to assign uncertainty for activity factors.

POTENTIAL IMPROVEMENTS:

- ***Ensure sponsored studies robustly quantify uncertainty***
- ***Strengthen uncertainty quantification methods and efforts***
- ***Develop methods and empirical foundation for activity factor uncertainty quantification.***

New Research Efforts in the Context of Many Other Studies



Source: Heath et al. 2015

POTENTIAL IMPROVEMENTS: Coordination amongst studies could be enhanced.

Confidence in inventory accuracy can be potentially increased if measurements are paired with inventory contemporaneously and systematically.

For Further Information

JISEA report:

<http://www.nrel.gov/docs/fy16osti/62820.pdf>

Webinars offered:

1. date/time
2. date/time

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