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Characterizing Global Supply Chains

Incorporating measurements for robust life cycle-based emissions accounting

October 2024

SLR

State of the global LNG market

401.42 MT
Global LNG Trade 2023

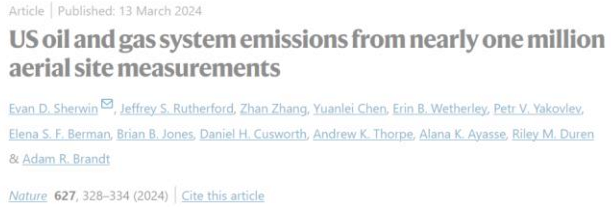
483.1 MTPA
Global Liquefaction Capacity[1]

51
Importing Markets

20
Exporting Markets

[1]End-February 2024
All data from IGU World LNG Report – 2024 Edition: https://www.igu.org/resources/2024-world-lng-report/

Traditional bottom-up inventories consistently underestimate methane emissions from O&G compared to top-down measurements



Article | Published: 13 March 2024

US oil and gas system emissions from nearly one million aerial site measurements

Evan D. Sherwin, Jeffrey S. Rutherford, Zhan Zhang, Yuanlei Chen, Erin B. Wetherley, Petr V. Yakovlev, Elena S. F. Berman, Brian B. Jones, Daniel H. Cusworth, Andrew K. Thorpe, Alana K. Ayasse, Riley M. Duren & Adam R. Brandt

Nature **627**, 328–334 (2024) | Cite this article

"The six-region weighted average is 2.95% (95% CI 2.79%, 3.14%), or roughly three times the national government inventory estimate. "

Article | Open access | Published: 25 April 2023

Creating measurement-based oil and gas sector methane inventories using source-resolved aerial surveys

Matthew R. Johnson, Bradley M. Conrad & David R. Tyner

Communications Earth & Environment **4**, Article number: 139 (2023) | Cite this article

"...comprehensive upstream OG sector methane inventory for British Columbia, Canada, which while approximately 1.7 times higher than the most recent official bottom-up inventory..."

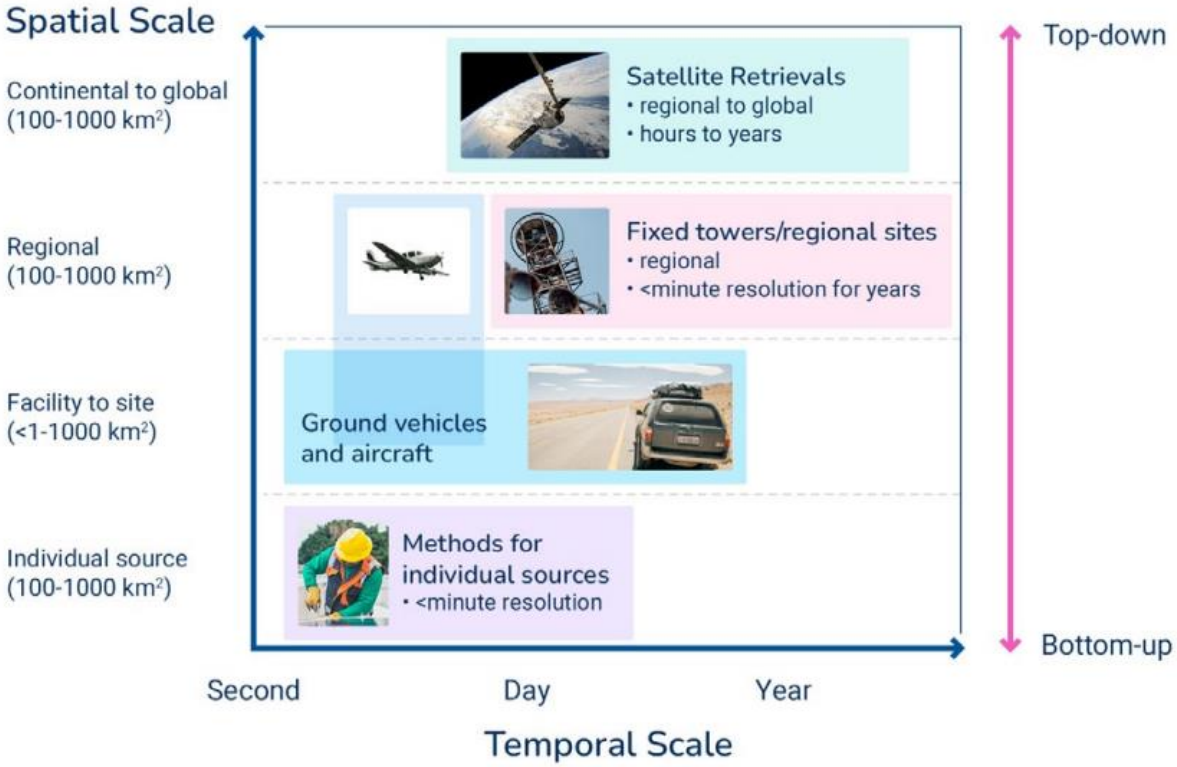
Assessment of methane emissions from the U.S. oil and gas supply chain

RAMÓN A. ALVAREZ, DANIEL ZAVALA-ARAIZA, DAVID R. LYON, DAVID T. ALLEN, ZACHARY R. BARKLEY, ADAM R. BRANDT, KENNETH J. DAVIS, SCOTT C. HERNDON, DANIEL J. JACOB, [...], AND STEVEN P. HAMBURG +14 authors Authors Info & Affiliations

SCIENCE · 21 Jun 2018 · Vol 361, Issue 6398 · pp. 186-188 · DOI: 10.1126/science.aar7204

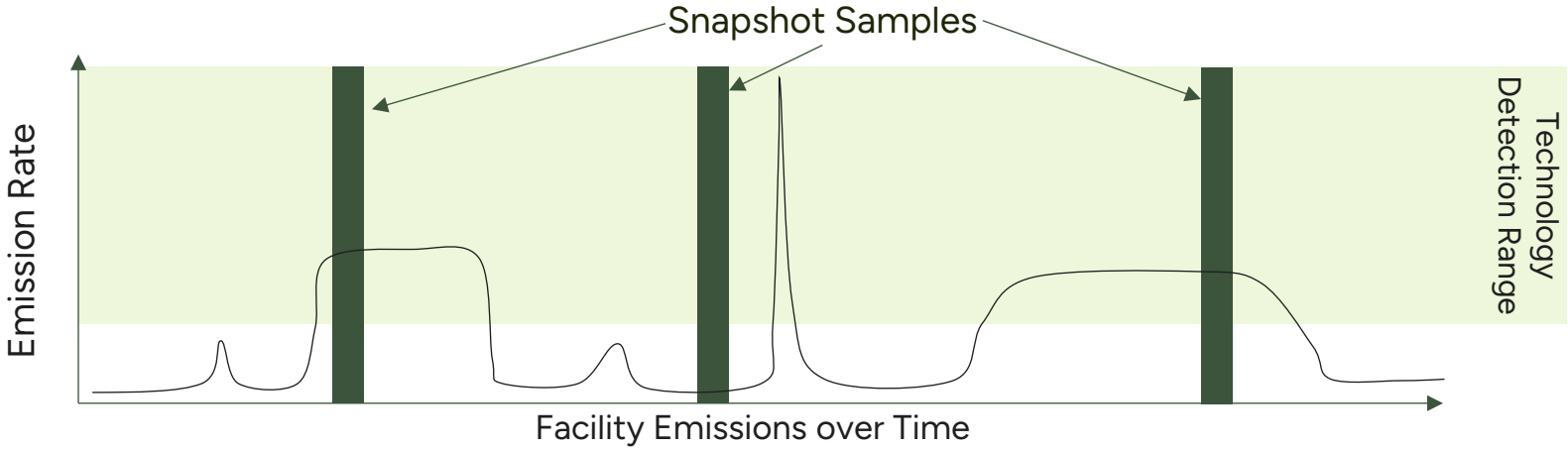
"...2015 supply chain emissions is 13 ± 2 teragrams per year, equivalent to 2.3% of gross U.S. gas production. This value is ~60% higher than the U.S. Environmental Protection Agency inventory estimate..."

The methane quantification technology space has advanced rapidly to include a wide variety of options...

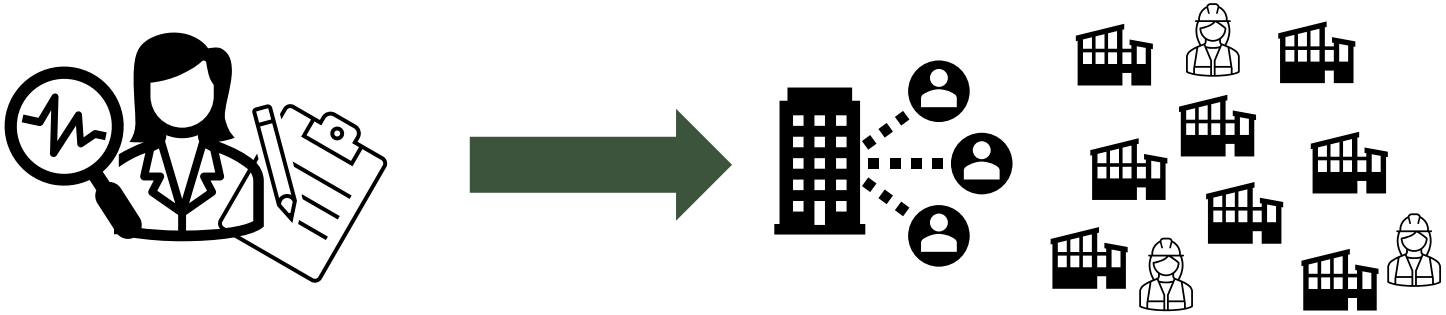


Source: Methane Guiding Principles Best Practice Guide 2024

...designing measurement programs is challenging, especially if you want to understand the emissions of an individual facility

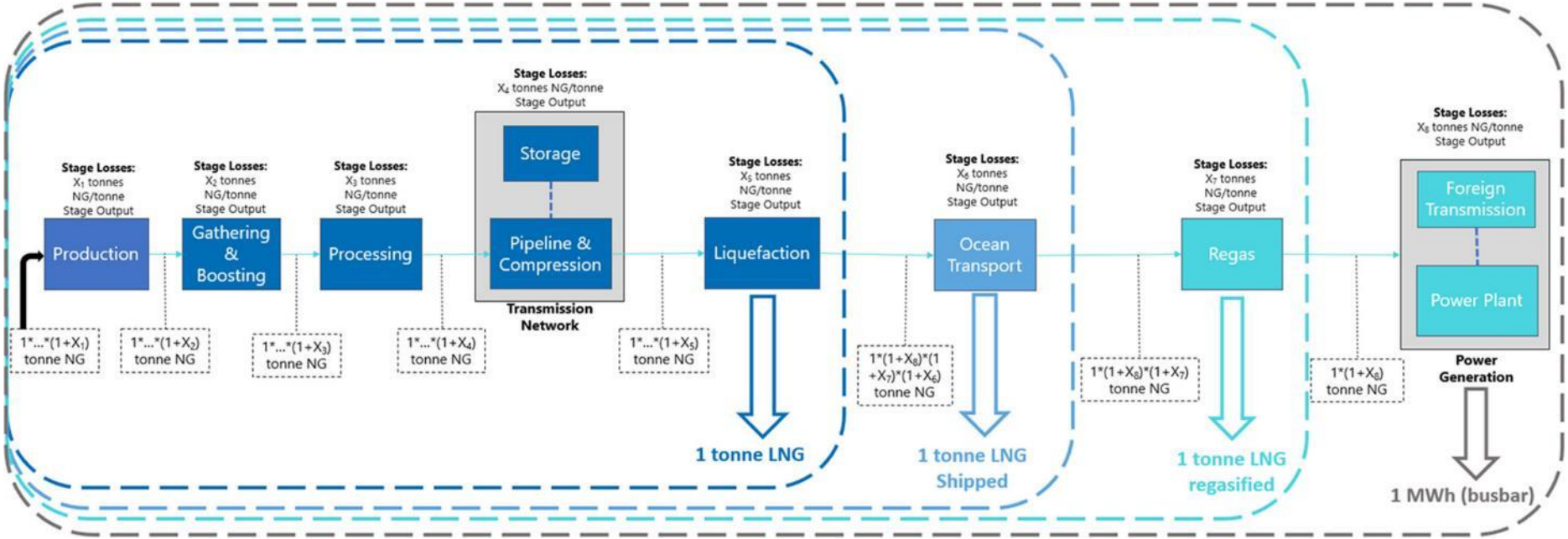


Research on protocols and models for translating measurements into annual inventories is advancing, but some hurdles remain to move from R&D to implementation “at scale”



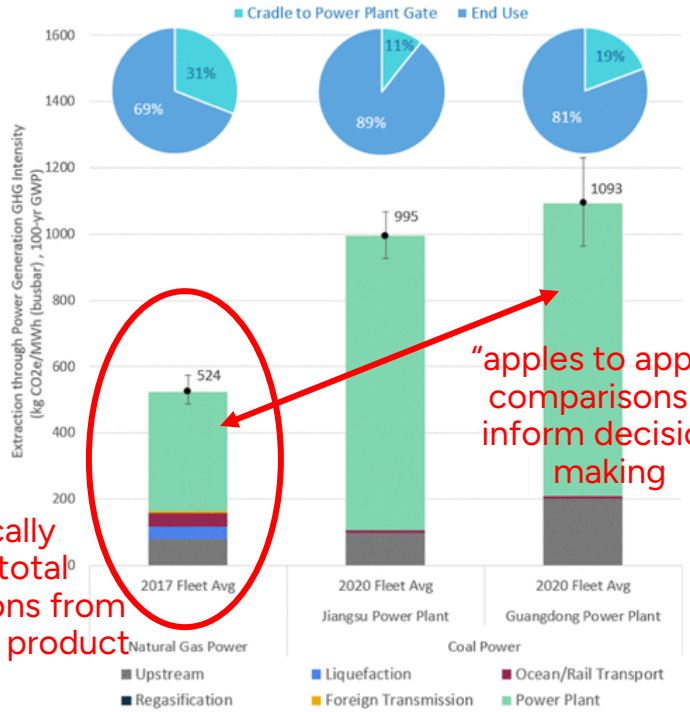
- How do you prove a protocol? Will a protocol produce the same result no matter who is using it?
- Will results from different protocols be comparable?
- How do we implement something that is sustainable long term (resource constraints)?
- How do we extrapolate snap-shot measurements to represent time-averaged annual inventories?
- How can we align MMRV reporting with state and federal regulatory frameworks?

What is a Life Cycle Assessment (LCA)?



Source: Roman-White et al. 2021, ACS Sustain. Chem. Eng. 9 (32)

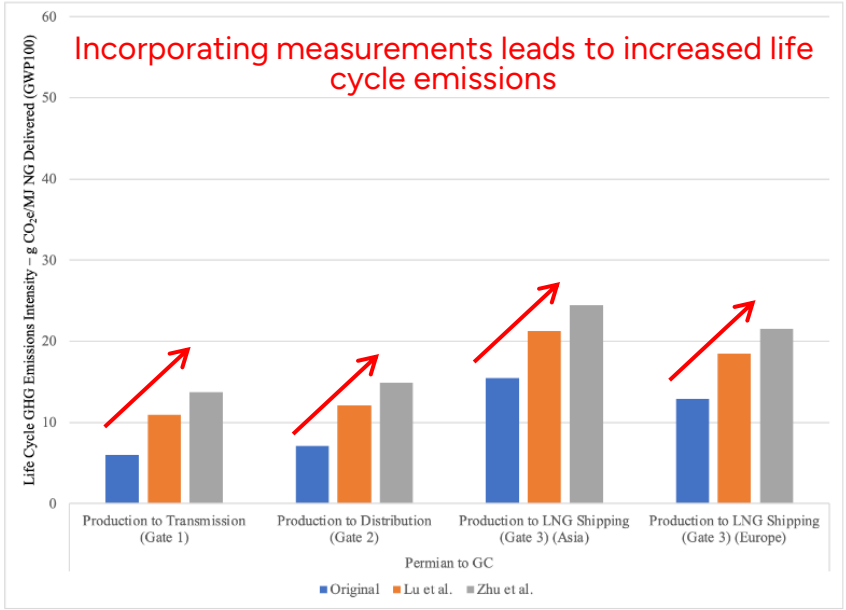
LCAs provide a comprehensive, consistent set of guidelines for estimating GHG intensity across the entire supply chain, but must be informed by measurements to be accurate



"apples to apples" comparisons to inform decision-making

Holistically assess total emissions from a given product

From Roman-White et al. 2021

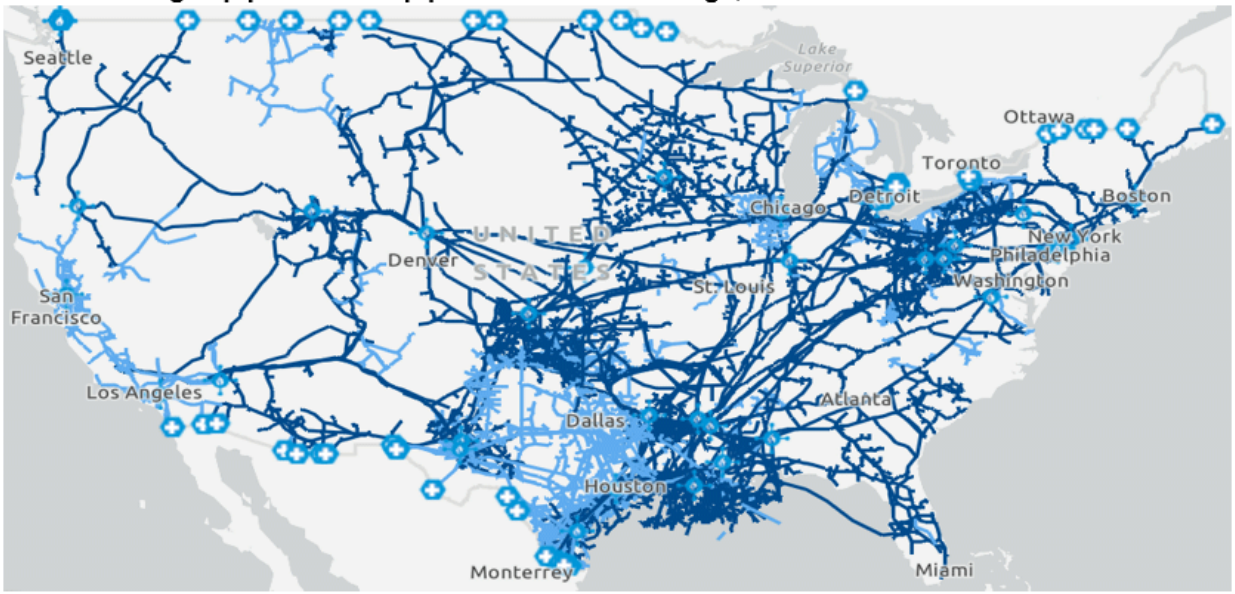


From NPC Charting the Course 2024, Chapter 4

Supply-chain specific LCAs are necessary to represent different global supply chains, national and regional average LCAs are insufficient to support commercial decision making

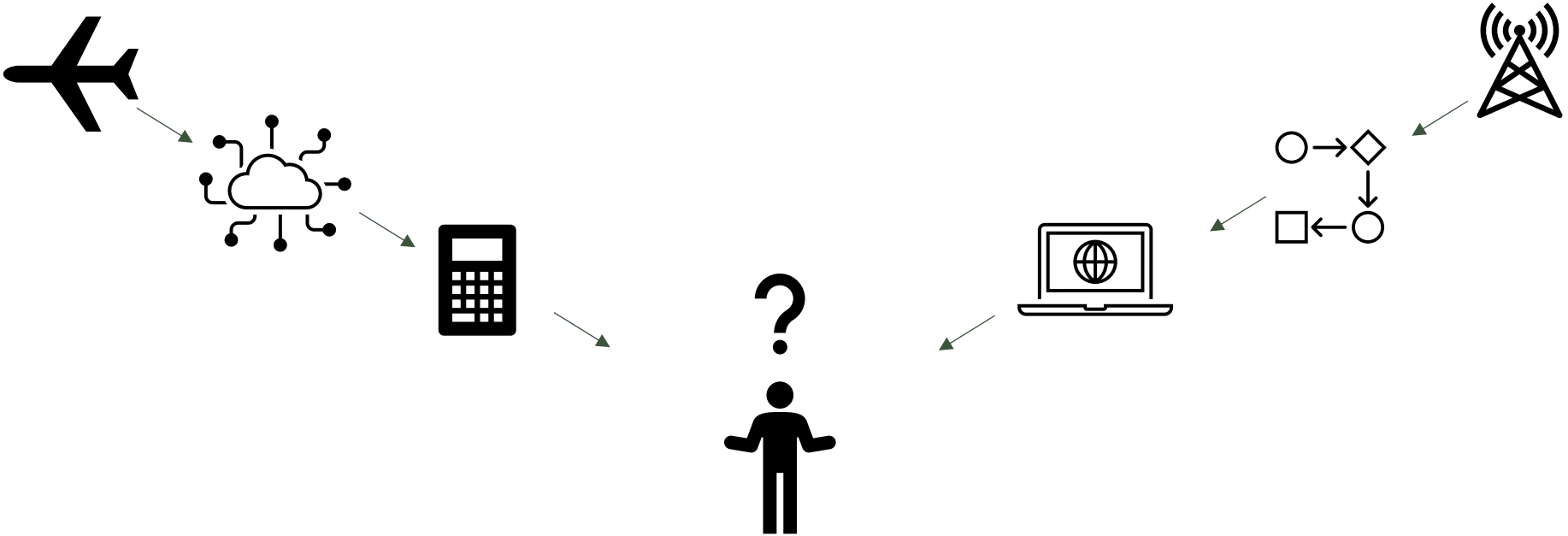
Global frameworks must consider the complexity of the U.S. natural gas supply chain

U.S. natural gas pipelines and pipeline border crossings, 2023



Source: U.S. Energy Information Administration, U.S. Energy Atlas, January 29, 2024
Note: Light-blue lines are intrastate pipelines, dark-blue lines are interstate pipelines, and + are border crossings.

To compare global supply chains, we must combine measurement data with LCA models and robust verification procedures in a process that is repeatable and produces decision-useful results



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