Oil & Gas Methane Emissions: Lessons from Scientific Studies

Steven Hamburg
Chief Scientist
Environmental Defense Fund

EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work

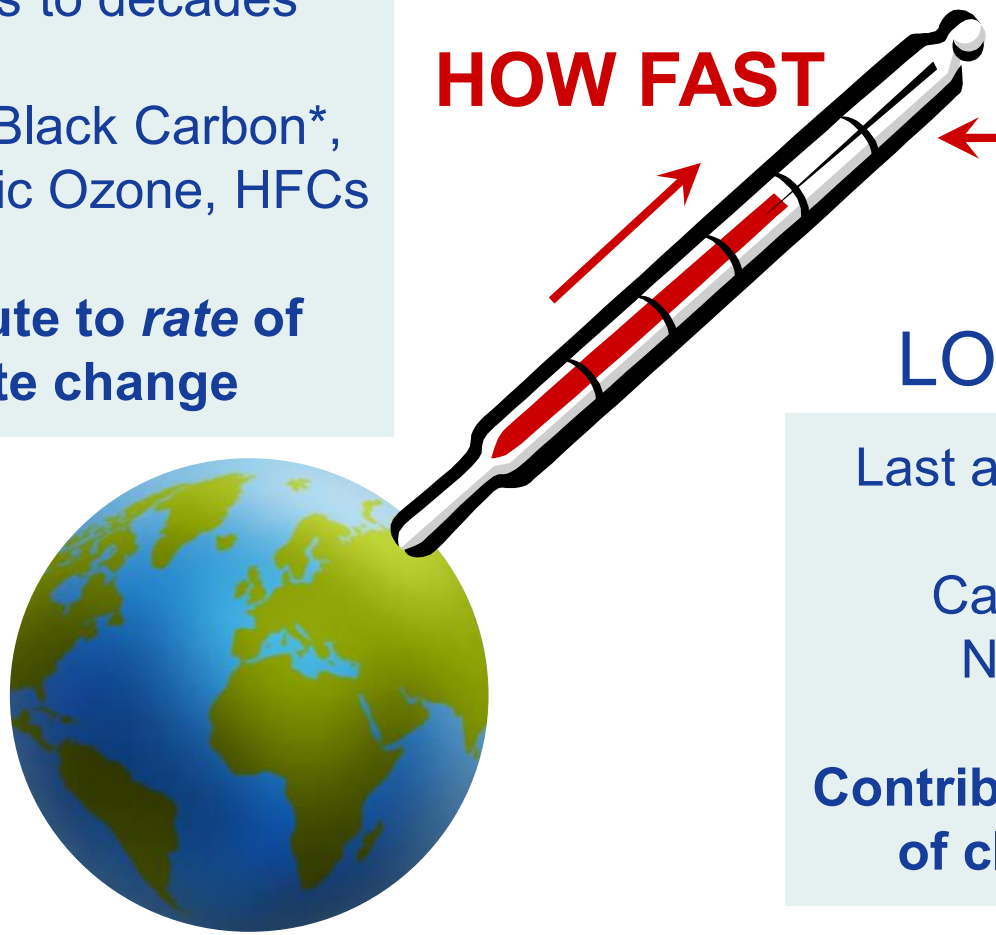
Distinct pollutant impacts on warming

SHORT-LIVED

Last days to decades

Methane, Black Carbon*, Tropospheric Ozone, HFCs

Contribute to *rate* of climate change



LONG-LIVED

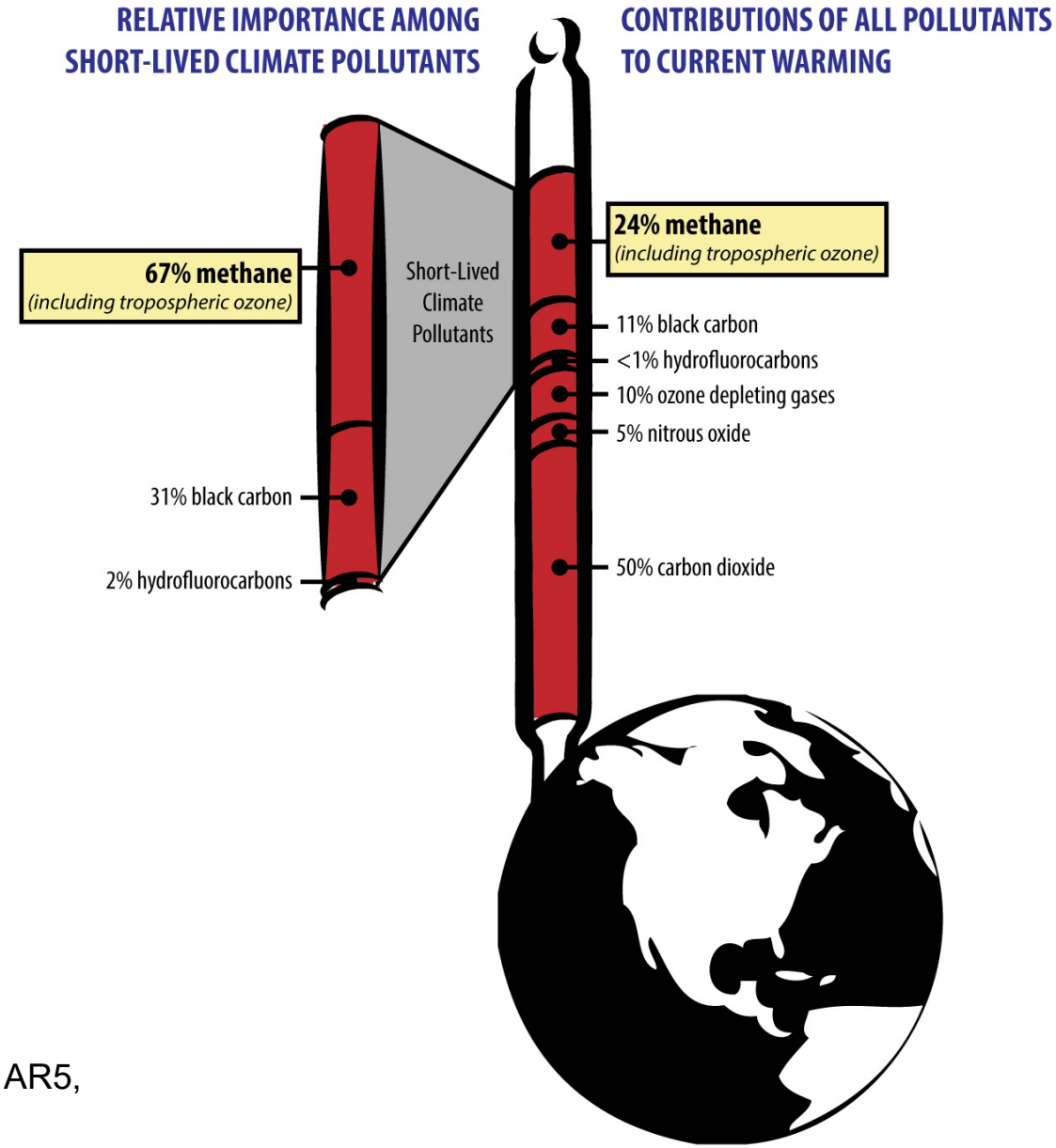
Last a century or more

Carbon Dioxide, Nitrous Oxide

Contribute to *magnitude* of climate change

**Black carbon not a gas, but a sunlight-absorbing aerosol*

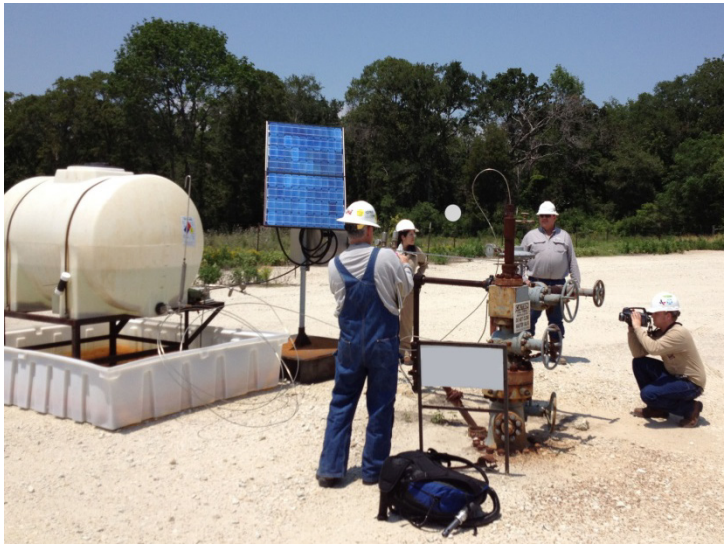
CH_4 causes ~25% of today's radiative forcing



Adapted from IPCC AR5, Table 8.SM.6

Catalyzing Science

EDF Coordinating 16 studies with >140 researchers from 40 institutions



Read more:
edf.org/climate/methane-studies

5 principles:

- Led by *academic scientists*
- Employ *multiple methodologies* whenever possible
- Seek review by *independent* scientific experts
- Make all data *public* to ensure *transparency*
- Publish results in a *peer reviewed science journal*

~~27~~ 33 Published Papers

1. **December 2013:** UT Production study: http://www.pnas.org/lookup/doi/10.1073/pnas.1304880110
2. **May 2014**: NOAA DJ Basin Flyover: http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/pdf
3. **November 2014:** HARC/EPA Fence-line study: http://pubs.acs.org/doi/abs/10.1021/es503070q
4. **December 2014** UT Pneumatics Study: http://pubs.acs.org/doi/abs/10.1021/es5040156
5. **December 2014** UT Liquid Unloadings Study: http://pubs.acs.org/doi/abs/10.1021/es504016r
6. **January 2015:** Harvard Boston Urban Methane Study: http://www.pnas.org/content/early/2015/01/21/1416261112
7. **February 2015:** CSU T&S study: Measurement paper: http://pubs.acs.org/doi/abs/10.1021/es5060258
8. **February 2015:** CSU G&P study: Measurement paper: http://pubs.acs.org/doi/abs/10.1021/es5052809
9. **March 2015:** WSU Local Distribution study: http://pubs.acs.org/doi/abs/10.1021/es505116p
10. **May 2015:** CSU G&P study, Methods paper: http://www.atmos-meas-tech.net/8/2017/2015/amt-8-2017-2015.html
11. **July 2015**: CSU T&S study, National results paper: http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01669
12. **August 2015:** CSU G&P, study National results paper: http://pubs.acs.org/doi/abs/10.1021/acs.est.5b02275

Barnett Coordinated Campaign Papers (July 2015) papers 13-24

13. **Overview:** http://pubs.acs.org/doi/abs/10.1021/acs.est.5b02305
14. **NOAA led Top-down study**: http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00217
15. **Bottom-up inventory - EDF**: http://pubs.acs.org/doi/abs/10.1021/es506359c
16. **Functional super-emitter study - EDF:** http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00133
17. **Michigan airborne study:** http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00219
18. **WVU compressor study:** http://pubs.acs.org/doi/abs/10.1021/es506163m
19. **Princeton near-field study**: http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00705
20. **Purdue aircraft study:** http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00410
21. **Aerodyne mobile study:** http://pubs.acs.org/doi/abs/10.1021/es506352j
22. **U of Houston mobile study:** http://pubs.acs.org/doi/abs/10.1021/es5063055
23. **Picarro mobile flux study**: http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00099
24. **Cincinnati tracer apportionment:** http://pubs.acs.org/doi/abs/10.1021/acs.est.5b00057
25. **December 2015:** Barnett Synthesis: http://www.pnas.org/content/112/51/15597.abstract
26. **March 2016:** Abandoned & Orphaned Wells: http://onlinelibrary.wiley.com/doi/10.1002/2015GL067623/full
27. **April 2016:** Gap Filling**:** Aerial survey of 8,000 production sites: http://pubs.acs.org/doi/abs/10.1021/acs.est.6b00705

Different Methodologies

"Top Down" studies reveal higher emissions than "Bottom Up" methods.

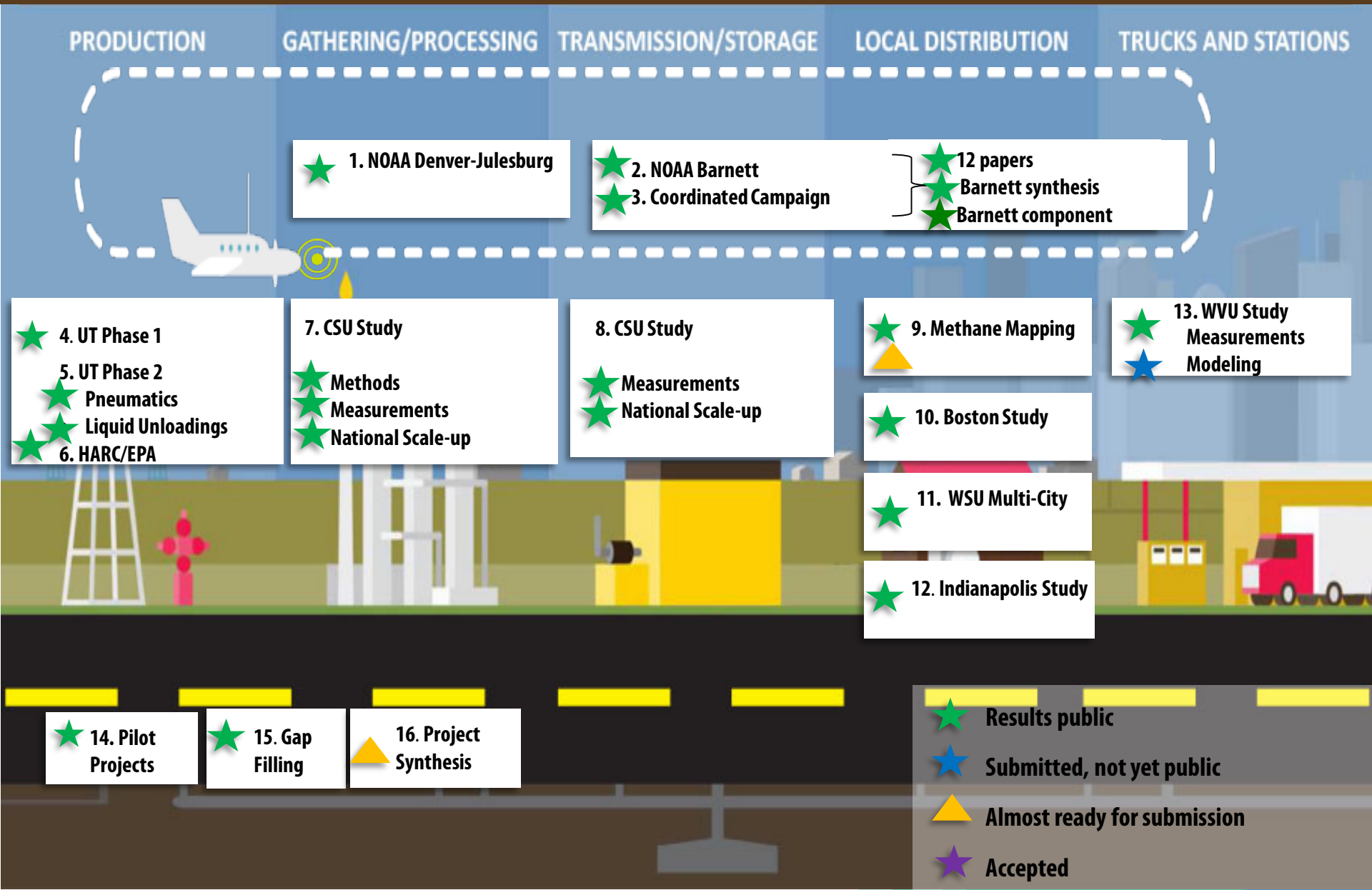
Top Down

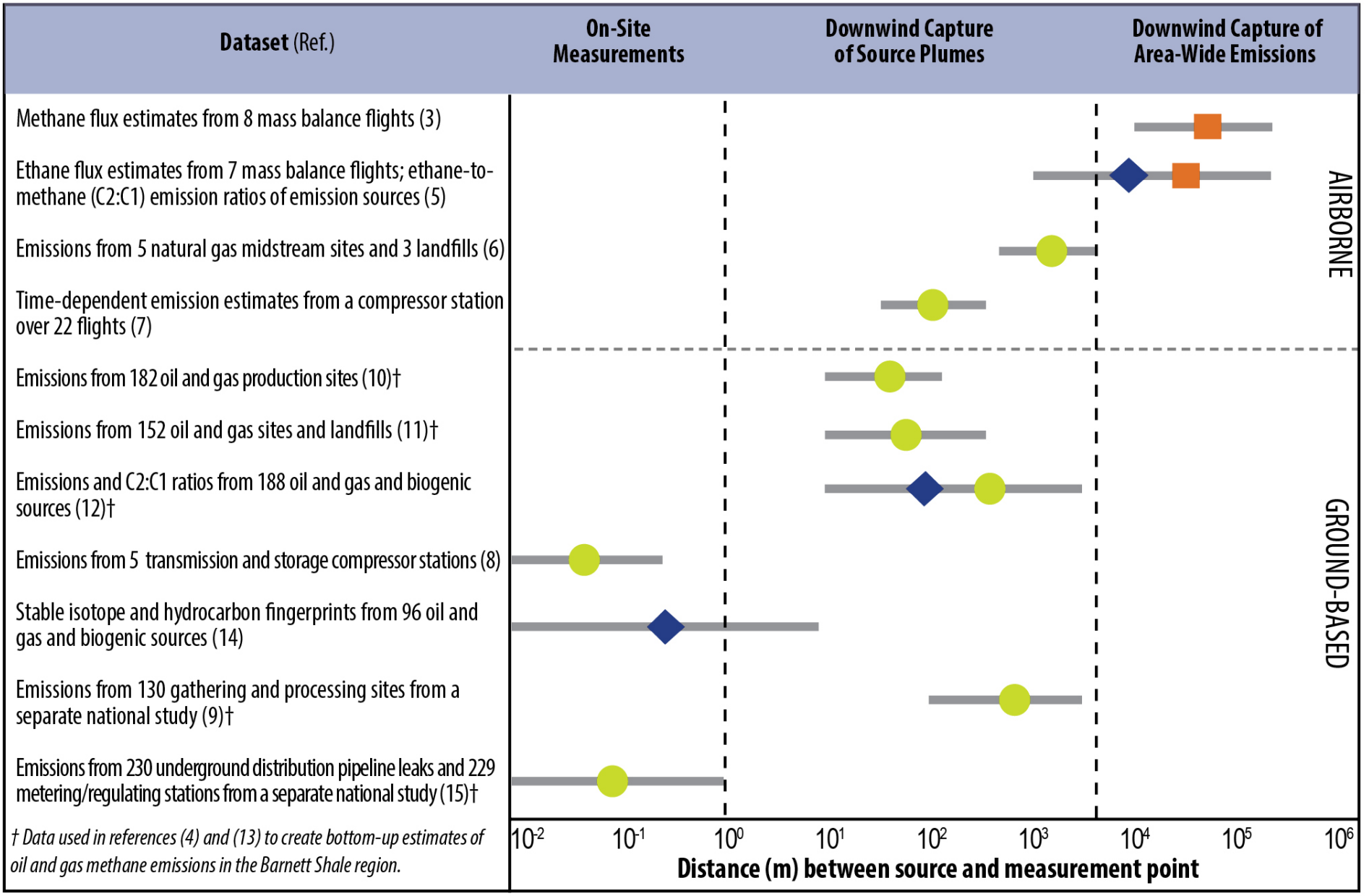
- Large scale-regional or national estimates
- Mass balance
- Atmospheric transport models
- Enhancement ratios (e.g., CH4/CO2)
- Attribution to oil & gas required

Bottom Up

- Component- or activity-based
- Facility-level (0.05 to 5 km downwind)
- Combine emissions and activity factors

EDF STUDIES BY SUPPLY CHAIN SEGMENT: March 2017

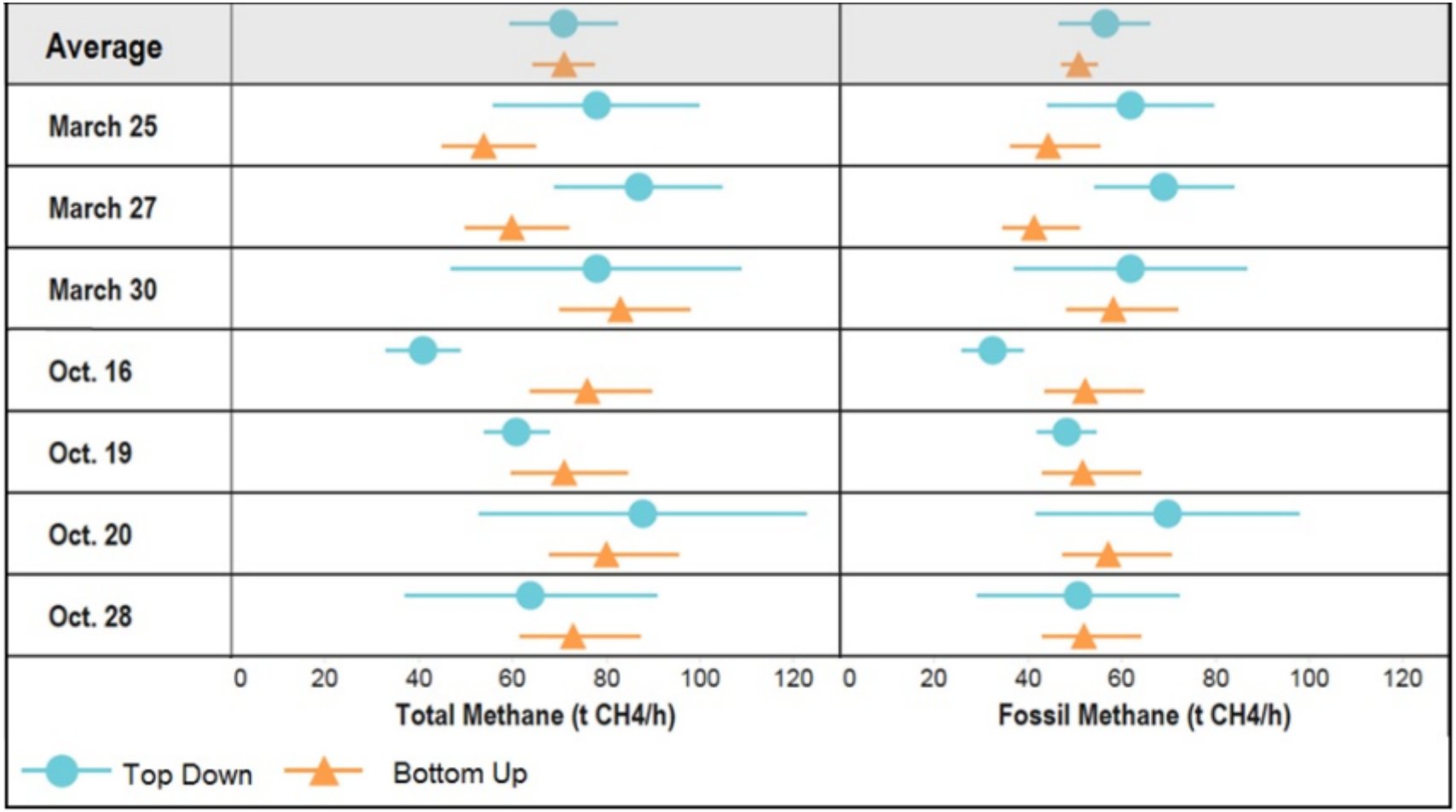




Harriss et al. ES&T (2015)

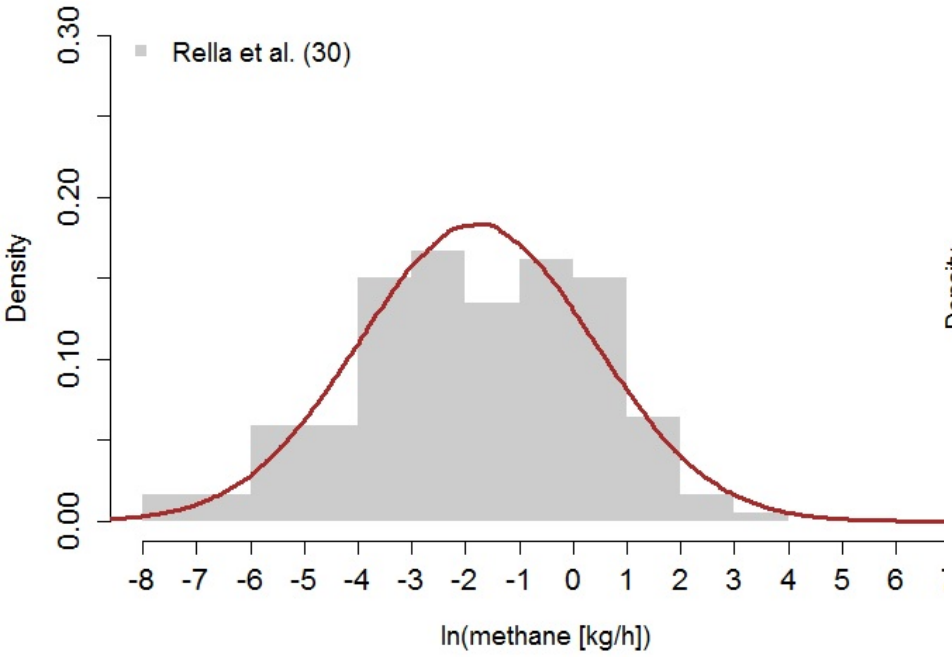
Barnett: Top-Down and Bottom-Up agree

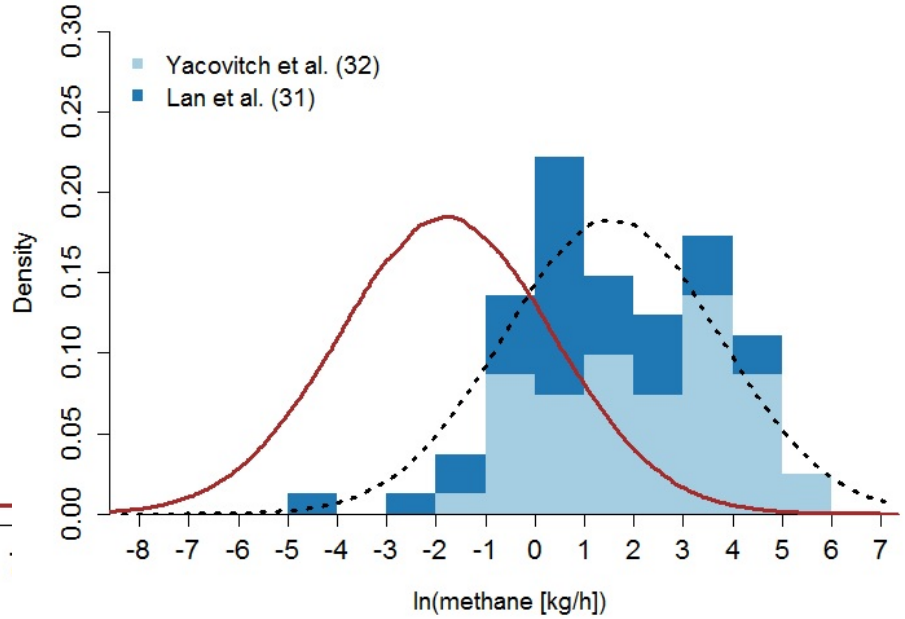
Mean Relative Difference: 0.1% ± 21% (total) and 10% ± 32% (fossil)

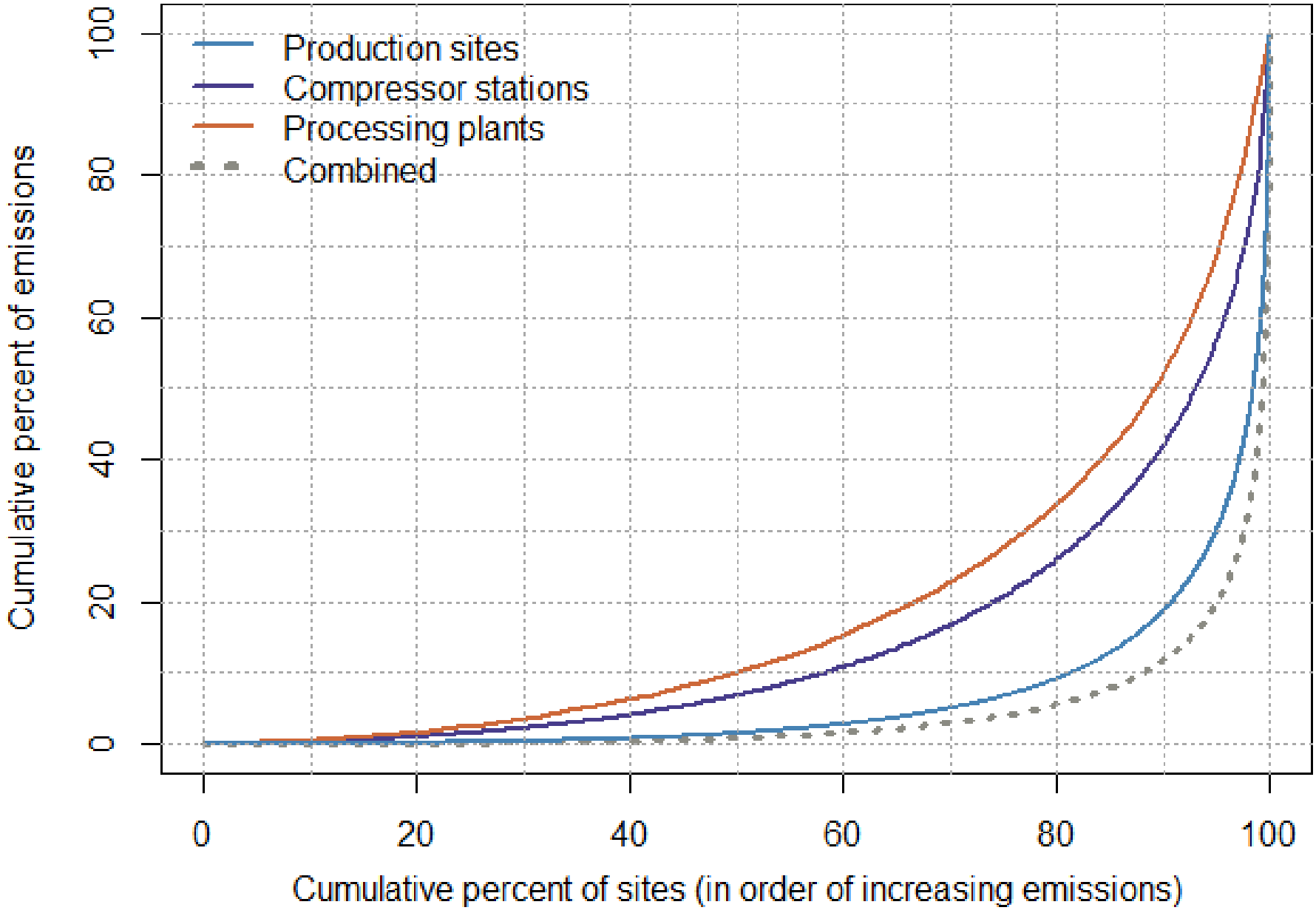


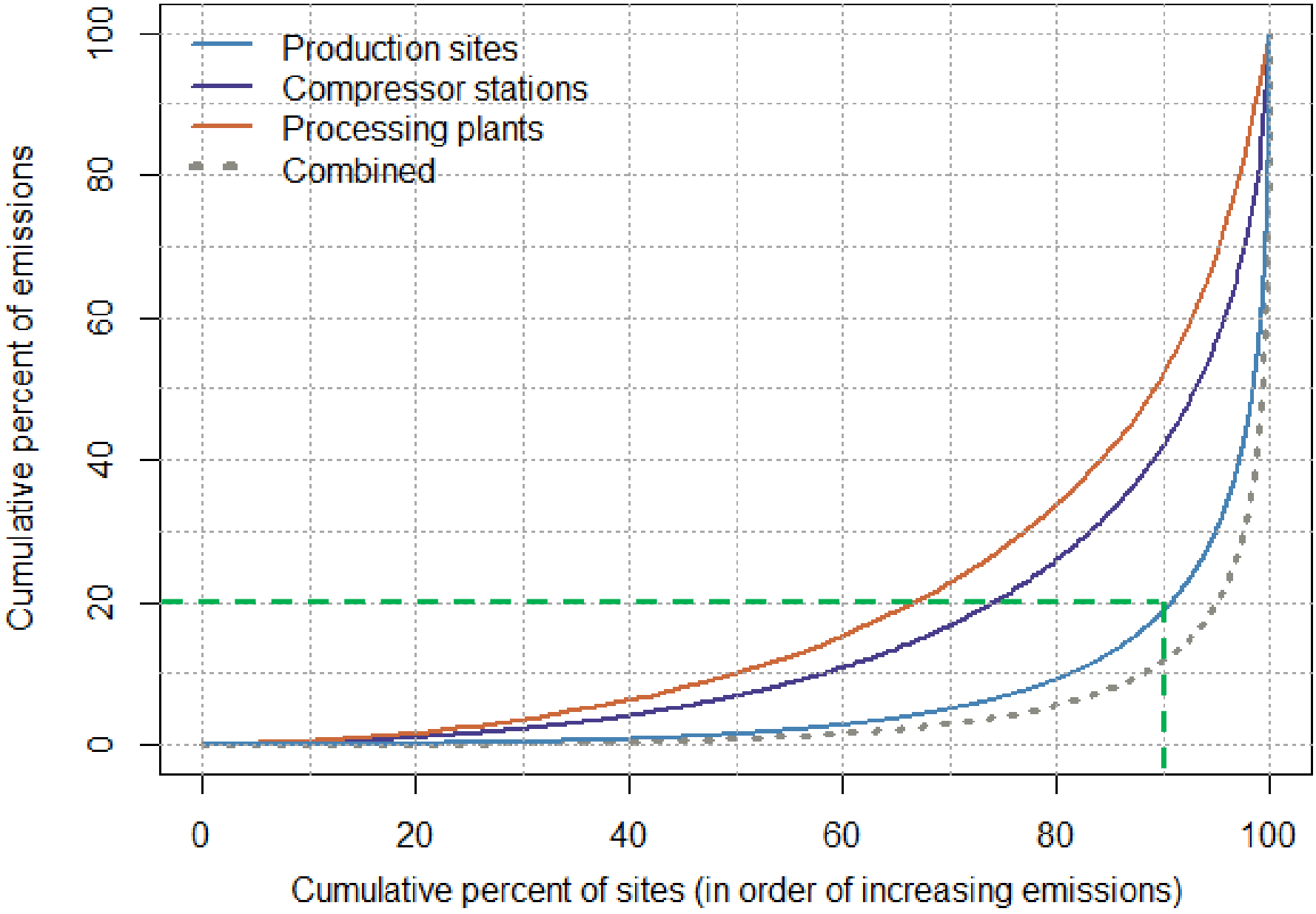
Zavala-Araiza et al. 2015 (PNAS)

Integrating Datasets – understanding the fat tail






Production sites
Compressor stations
Processing plants
Combined
Cumulative percent of emissions
0
20
40
60
80
100
Cumulative percent of sites (in order of increasing emissions)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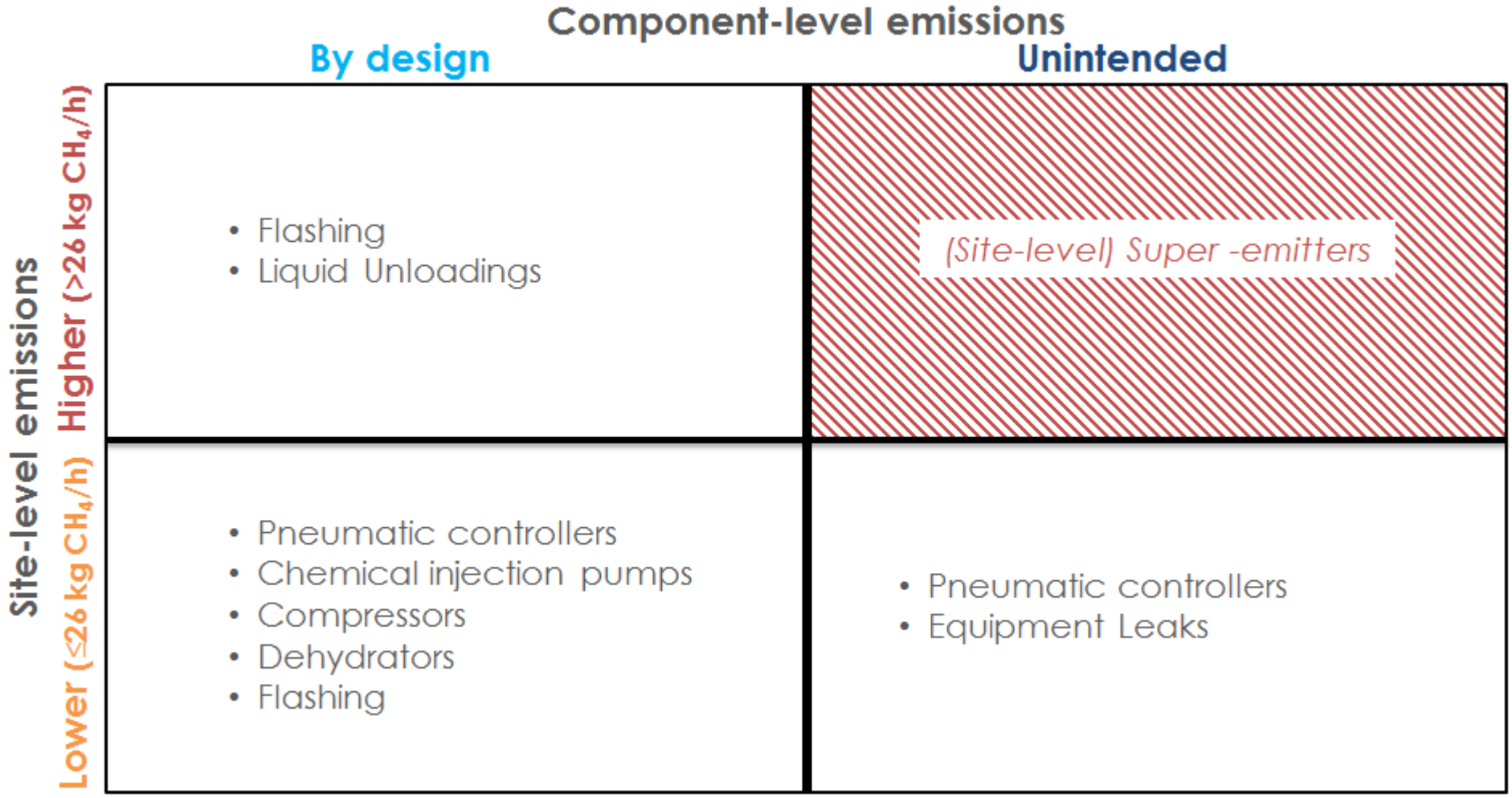
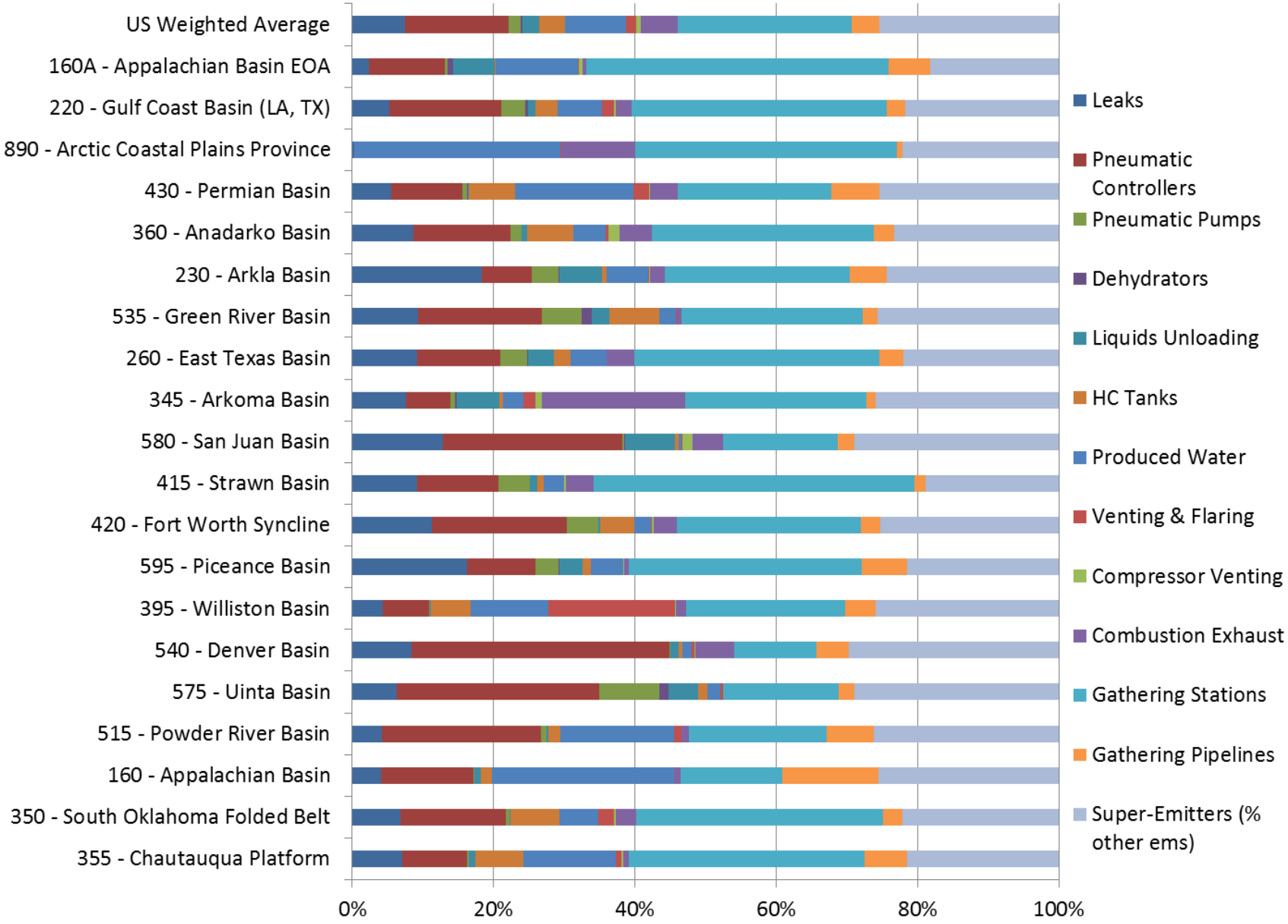
Cumulative percent of sites (in order of increasing emissions)

Tank flashing and liquids unloading explain the magnitude but not the prevalence of high-emitting well pads

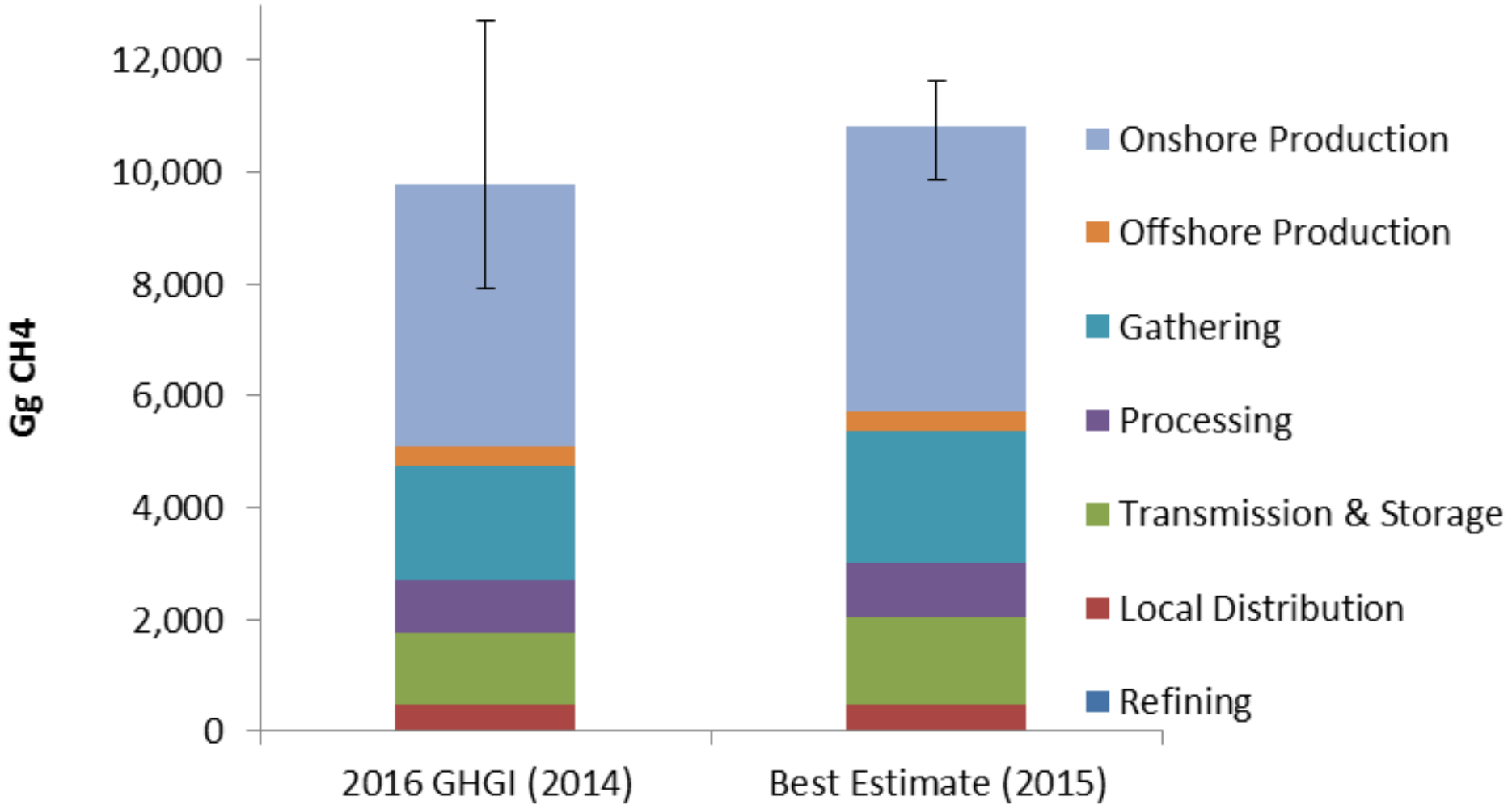


Zavala-Araiza D, et al. Nature Communications 2017.

Relative contribution of upstream emission sources varies substantially among basins



Preliminary
U.S. O&G CH_4 emissions
2016 EPA GHGI (9.9 – 11.7 vs 9.8 Tg)



Ubiquitous Fat tail distributions

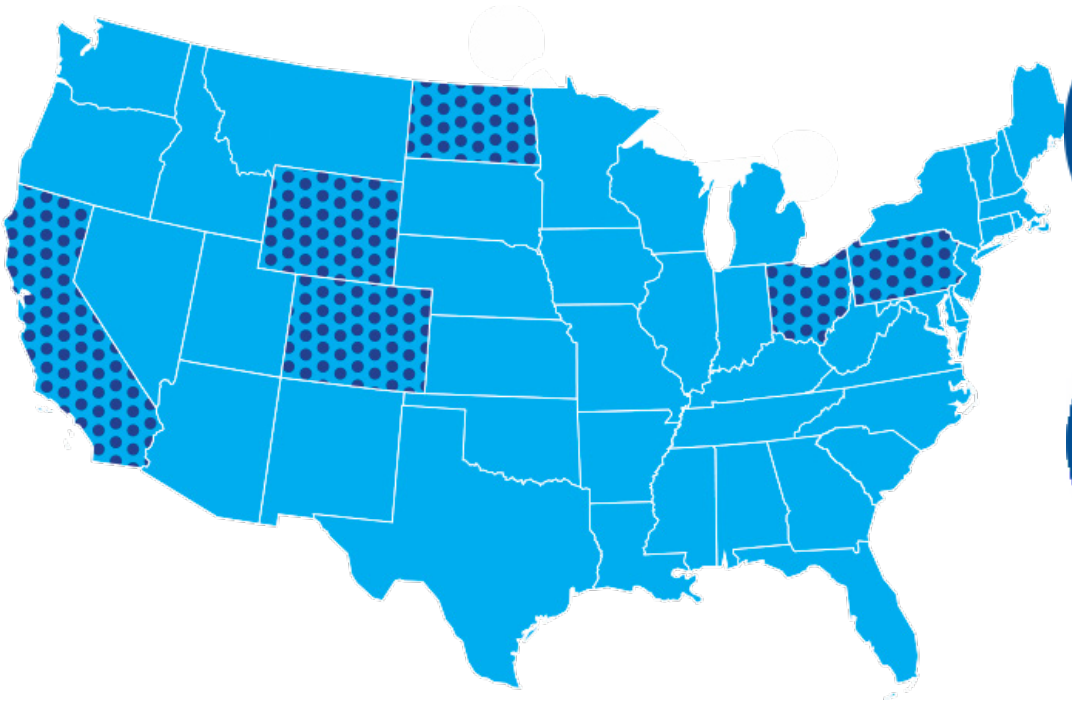
- How important?

- What it tells us about of methane emissions.

Findings Convergence

- Reduce uncertainty of TD approaches using **replicate mass balance measurements**
- Use **signature compound** (ethane) to **distinguish fossil** CH_4 from **biogenic** CH_4 for TD approaches
- BU estimates require **accurate facility counts** of all major sources
- Emission factors require **effective characterization of entire distribution** of sources:
  - Sampling must capture low-probability, high-emitting sources
  - Emission distributions must **capture magnitude and frequency of high-emitting sources**

U.S. Methane Regulations Lessons Learned



Environmental Protection Agency oil & gas methane regulations in place.

EPA Action + States taking additional regulatory actions to address oil and gas methane emissions.

Higher Emissions

As a whole, oil & gas methane emissions are higher than conventional estimates suggest.

Super Emitters

Recurring, unpredictable problem not accounted for in inventories.

Regulations Work

- Industry/Govt/NGO can create collaborative, effective regs.
- Operators report success in CO.
- LDAR important tool for now.
- Tanks larger source.
- Equipment counts are low

Global Methane Action

2014: **Colorado :** first US State to develop O&G methane regulations.

2015: **IEA Frames the Opportunity:** Scales potential reductions from O&G methane

Alberta: Alberta to cut 45% of oil & gas methane emissions by 2025

2016: **Investor Support:** Investors of $3 trillion back strong global methane regulations

North America. Mexico, Canada, U,S. pledge O&G methane cut of 45%

Major Oil and Gas companies (OGCI) announce plans

Global Momentum. Ministers from 19 countries identify O&G methane reductions as “next big climate opportunity”

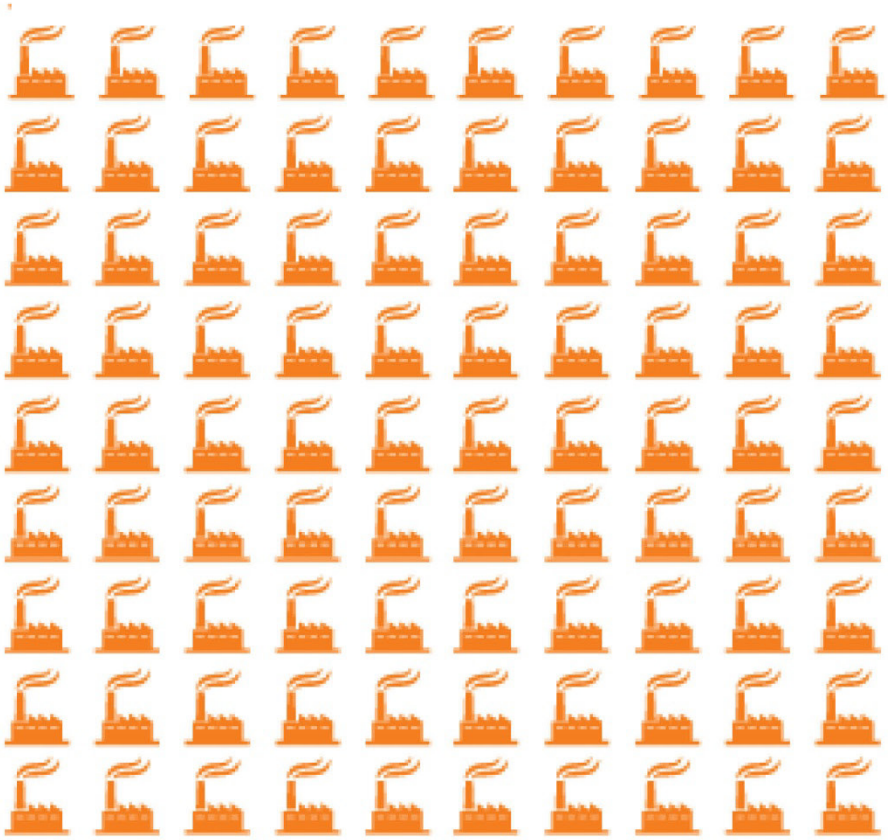
2017: **US State Leadership:** Ohio and California announces policies. O&G production covered by US state regulations 9th largest producer

North America and Norway Leading

- Norway
  - CO2 Tax Act, Petroleum Act (Flaring), Pollution Control Act
  - New venting can be almost eliminated
  - More sources identified than previously thought
  - Uncertainty about fugitive emissions
- Canada (Draft Federal regs expected in March)
  - Equipment count surveys found significantly more equipment than in inventory
  - Measurement data expected in Spring, CHOPs an issue
- Mexico
  - New methane regs expected to be announced this year.

Methane Reductions Can Have an Immediate Impact

LOWERING GLOBAL O&G METHANE EMISSIONS **45%**



CLOSING

1000

COAL PLANTS*

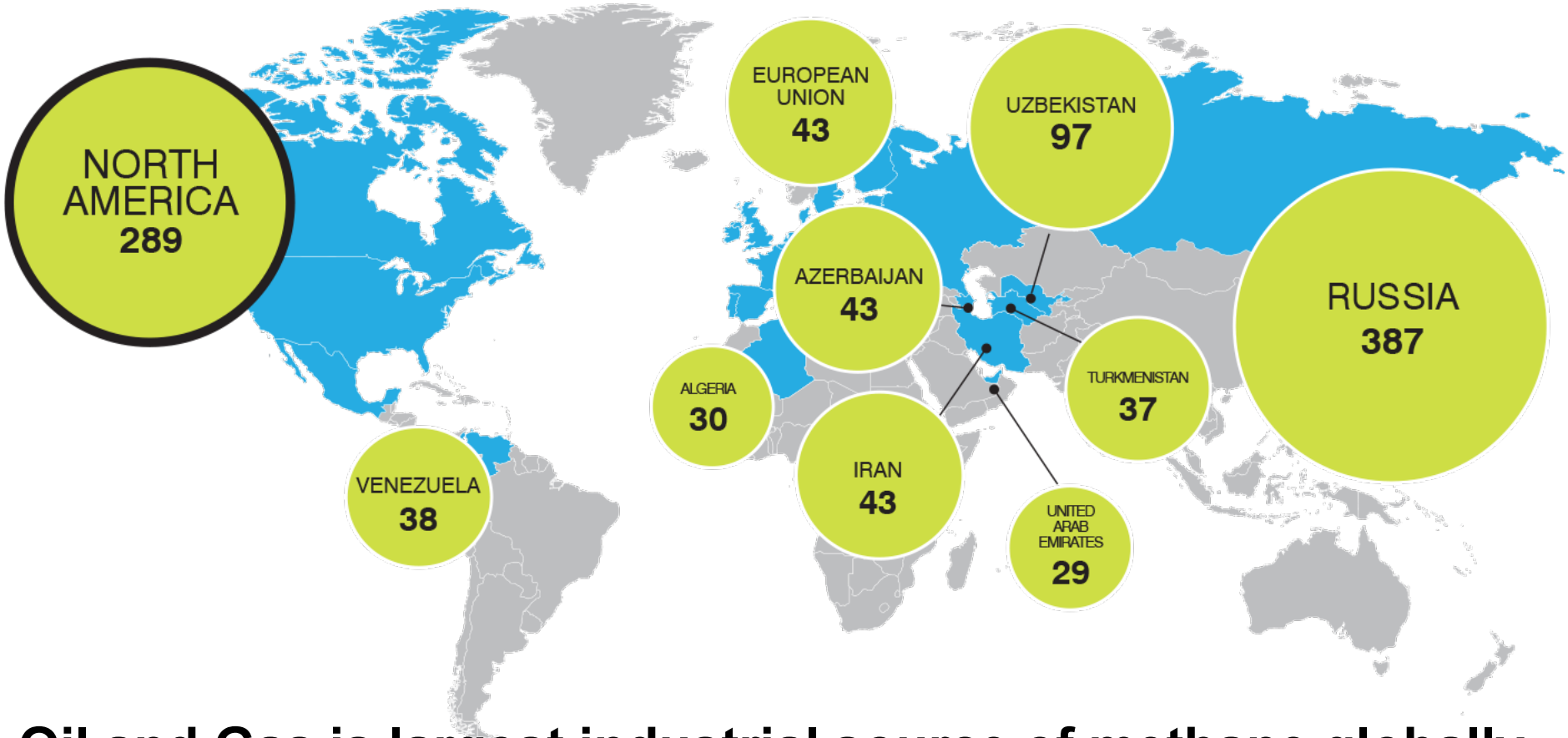
Each icon represents 10 coal plants

*Estimate based on EPA 2013 Greenhouse Gas Inventory

Estimated – we need more empirical data!

TOP OIL & GAS METHANE EMITTERS GLOBALLY

IN MILLION METRIC TONS CO_2e



Oil and Gas is largest industrial source of methane globally. Scale of emissions shows further action needed.

Final Thoughts

- Empirical O&G methane emissions data required.
- Experience shows regulations can be developed and successfully implemented.
- Regulations need to address super-emitters.
- Transparency and reporting are key.
- Innovation can make reducing methane easier.


THANK YOU
shamburg@edf.org
Google maps
Street View
google.com/streetview